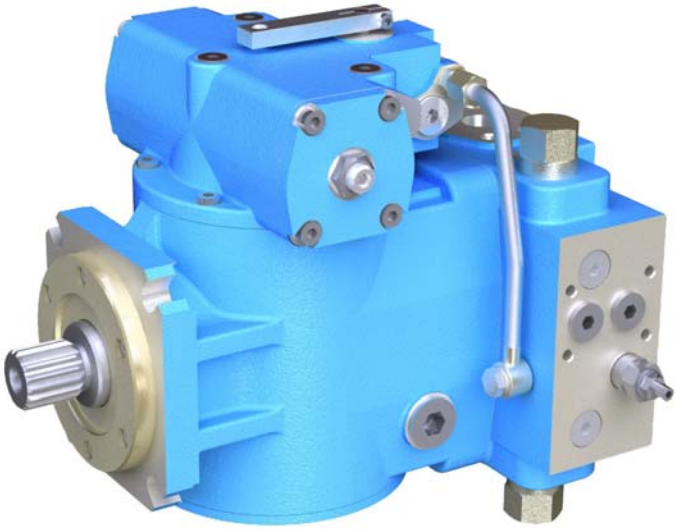
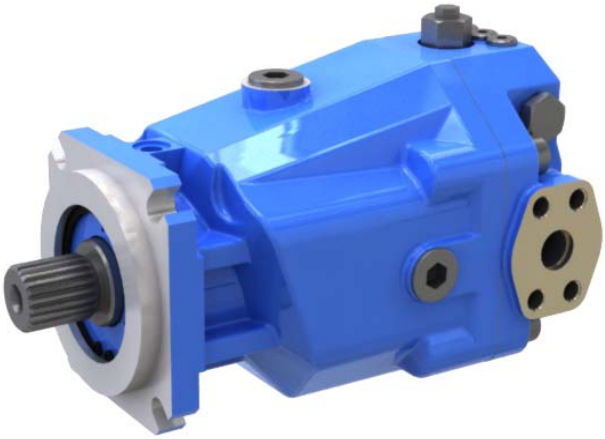
HST-71, HST-90
Hydrostatic Transmissions
Service Manual





PSM-Hydraulics
Ekaterinburg
2009

Introduction.

● Service Manual Application.

The given Manual provides the information and instructions on correct operation, application and after-sales service of series 416 hydraulic pumps and series 406 hydraulic motors, making up together the group of hydrostatic transmissions.
The Manual includes the description of hydraulic units and their components, the information on trouble shooting, instructions on adjustment and repair. Guarantee liabilities are valid in case the operation, service, repair, regulation and adjustment are done in strict compliance with recommendations provided by the given Manual. Disassembling of hydraulic units is not compulsory for some adjusting and service operations. Nevertheless the hydraulic units should be accessed easily and cleaned thoroughly before starting–up service, adjusting or repair operations. The working fluid pollution is the main cause of any hydraulic equipment breakdown. The purity requirements should be observed strictly especially while filter elements replacing, or adjusting and repairing.
For more detailed information see the web-site www.psm-hydraulics.com.

The Manual is not intended for overhauling of hydraulic units and their full disassembling.
Contact the authorized service network of **PSM-Hydraulics** for overhauling.
PSM-Hydraulics authorized service network provides repairs of any complexity level.
Contact our service centers for more details and information or our company directly:
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620100 Ekaterinburg, Russia
tel./fax +7 343 2646650
e-mail: trade@psmural.ru
web: www.psm-hydraulics.com

See the list of our service centers network on www.psm-hydraulics.com.

● Safety Precautions.

Follow the common safety Precautions during hydrostatic transmissions' operating and after-sales service.

● The working fluid is under high pressure.
Be careful during working fluid under pressure operating. Bleedings of working fluid under pressure as a result of hydrostatic transmissions' failure may be injurious to personnel's health.
Getting to the skin the working fluid may burn it. The working fluid may also penetrate under the skin causing serious infections and other negative consequences, therefore medical aid should be provided immediately.

● Cleaning and degreasing solvents.
Some solvents are highly inflammable. Avoid keeping close to the open fire springs.

● Blocking of vehicle moving (technological equipment).
Some procedures of service and operation may require the following additional security measures:
- lifting up of driving wheels;
- disconnecting of drive gear on the driving wheels (driving axle);
To prevent any possible injuries of personnel.

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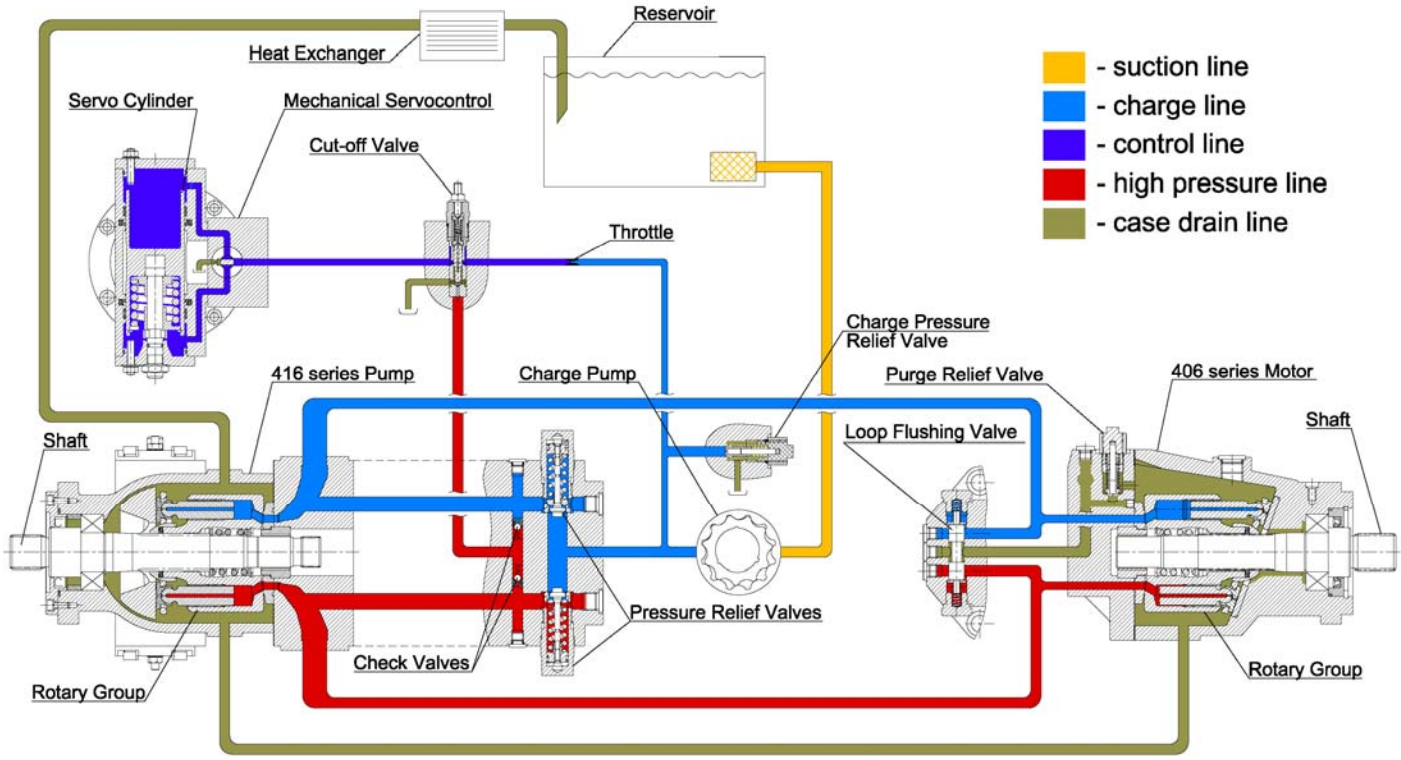
General Information

● Hydraulic Scheme of Hydrostatic Transmission



● Description of Hydrostatic Transmission HST-90

Hydrostatic transmission is a closed hydraulic system consisting of hydraulic pump and hydraulic motor. Hydrostatic transmission serves to deliver the mechanical energy from drive motor to the operating unit of the product.

Basic Closed Circuit.

Basic ports of the pump are connected to basic ports of hydraulic motor through hydraulic lines. The working fluid flows in different directions from pump to hydraulic motor returning back to the pump in the given closed circuit.
Each hydraulic line may be under high pressure. In operating mode the position of swash plate defines the direction of the working fluid flow and also points which of the hydraulic lines is under high pressure.

Drain Line and Heat Exchange.

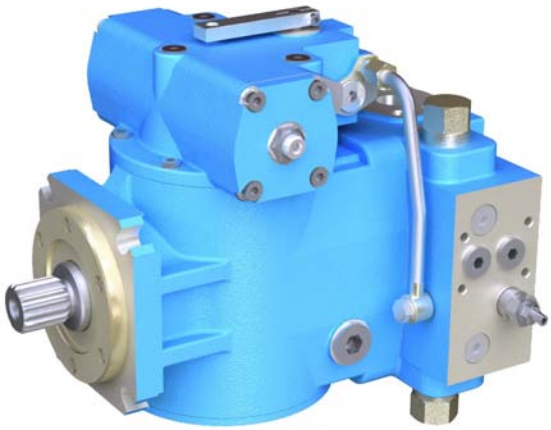
Drain lines are necessary for pump and hydraulic motor in order to aspirate the hot fluid from drain cavities. The hydraulic motor is to be connected to the drain line through drain port, located in the upper point to guarantee the filling up of hydraulic motor's drain cavity. It is recommended to connect the hydraulic motor's drain line to the bottom drain port of the pump. The bleed-off to the hydraulic reservoir comes through upper drain port of the pump. The heat exchanger serves to cool the bleeding working fluid before it gets into the hydraulic reservoir.

Description of HST-90 Components

● Series 416 Pumps. Basic Components

Series 416 variable displacement axial piston swash plate pumps serve to operate in closed hydraulic schemes. Pump output flow is proportional to shaft speed and working volume. The working volume is regulated steplessly from 0 to maximum point in all directions. The direction of fluid supply may be reversed by changing the angle of swash plate right-about of neutral position. The hydraulic pumps have iron housings. The round valve plate and steel embronze cylinder block are applied in the pumping unit of the hydraulic pump. They allow to boost the maximum working pressure and to increase the resource. The working volume of the pump is regulated by changing the angle of swash plate. The maximum working volume in hydraulic pumps may be limited in all directions by regulating screws.

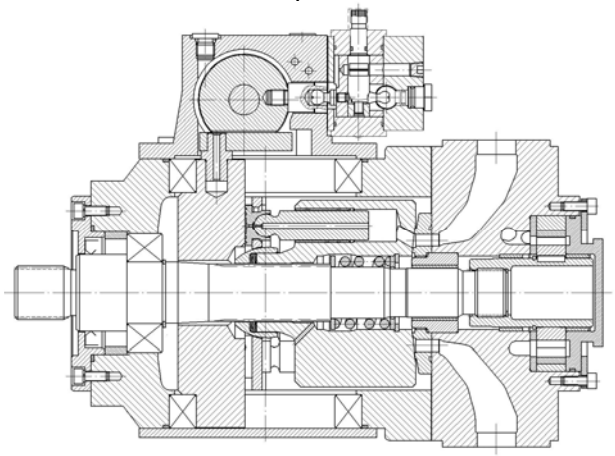
Series 416 Pump. General View



All connection dimensions are done according to ISO/SAE standards.

● Components.

Series 416 Pump. Sectional view



The pump consists of the following basic components:
- main pump;
- end cap;
- servo regulator;
- control mechanism.

● Main Pump

The main pump has the iron housing in which the following units are located:
- swash plate supported by two roller bearings, fixed on each side of the housing.
-shaft, coming through the pump. The front support of the shaft is a roller bearing, fixed in the housing. The end support of the shaft is a sliding bearing, fixed in the end cap.
- pumping unit, driving through splined joint of cylinder block and shaft. Piston heels of the pumping unit are retained to the swash plate and they slide on it during pumping unit rotation.
- seal carrier, fixed on the pump housing at mounting flange side. The seal is installed in the seal carrier.

● End Cap.
Series 416 pumps are equipped with end caps of different types.

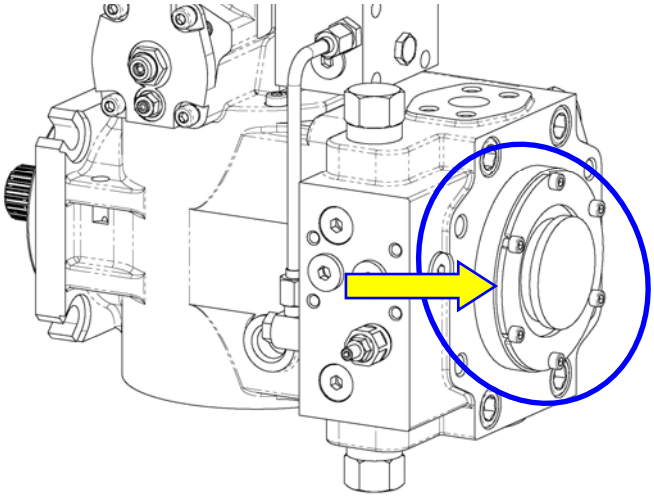
End Cap consists of the following parts:
- gerotor type charge pump;
- charge pressure valve;
- 2 pressure relief safety valves;
- cut-off valve + 2 check valves;
- filter.

End Cap type defines:
- the configuration of high pressure lines' connection ports;
- the configuration of suction line's connection port;
- availability/non-availabililty of cut-off valve;
- availability/non-availabililty of filter

WARNING! Removing of the end cap cancels the pump warranty.

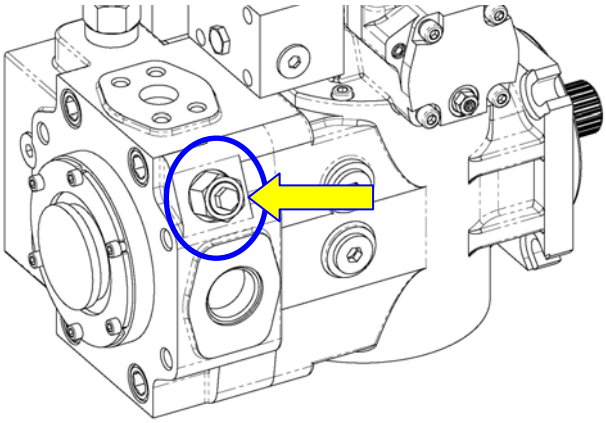
● Charge Pump.

Charge pump is a gerotor type fixed displacement pump. It is installed into the end cap. Charge pump drives by the shaft of main pump. Gerotor type charge pump serves to:
- compensating of bleeding in the main loop of HST. The bleeding appears as a result of leak flows in the rotary groups of pump and motor.
- creating and keeping of necessary pressure in suction line of the main pump for suction conditions improvement.
- creating and keeping of necessary pressure in control line.

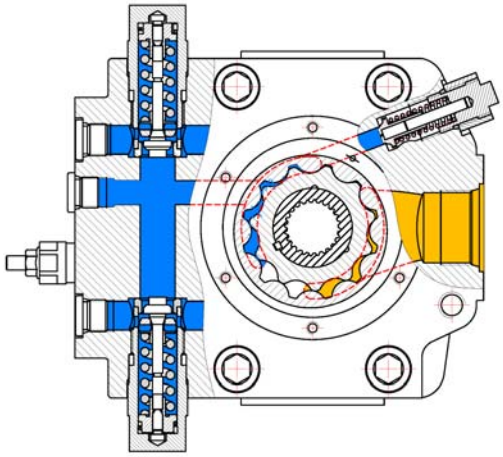


● Charge Pressure Valve.

The pressure, produced by charge pump should be constant in all operating modes in order to avoid the failure of hydrostatic transmission. The charge pressure is produced and controlled by charge pressure valve overflowing the working fluid from charge pump line to the drain cavity of main pump.
The charge pressure valve adjustment is set on the nominal revolutions of the pump at the swash plate neutral position. The charge pump releases when the swash plate angles aside.

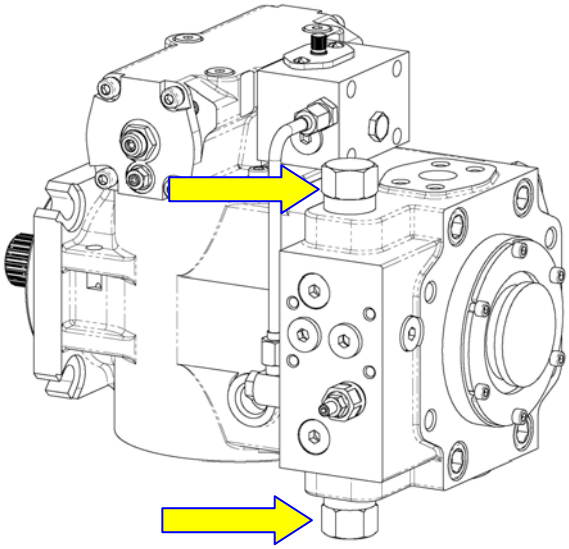


The interior arrangement, charge pump and charge pressure valve locations are shown at the sectional drawing.

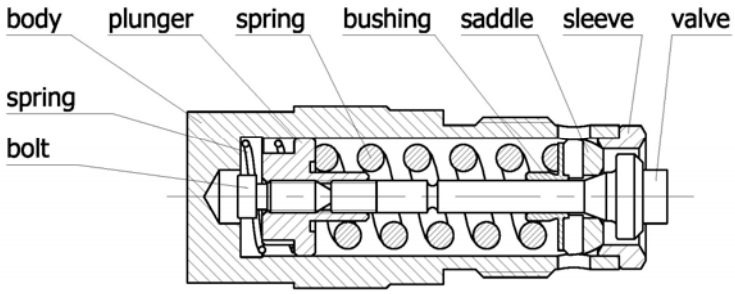


● Pressure Relief Safety Valves.

The two bilateral pressure relief valves serve to limit the overshoot pressure in the working tubes and to supply working fluid from charge pump to the suction line of main pump. Each valve is installed on one of the power lines.



Pressure Relief SafetyyValves Structure

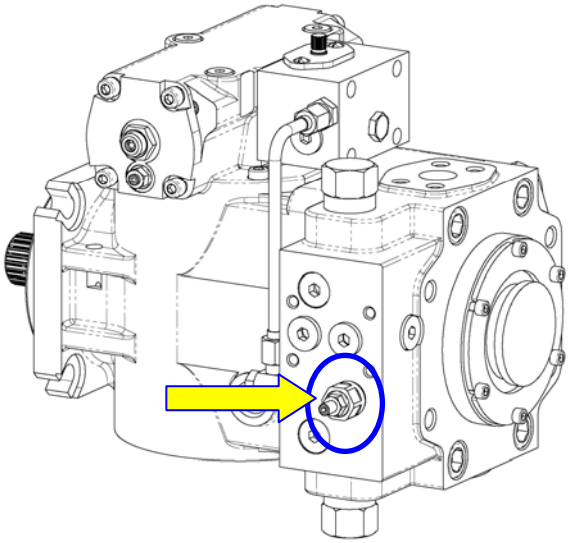


● Cut-off Valve and Check Valves.

The two check valves serve to deliver the working pressure to the cut-off valve (see HST scheme).

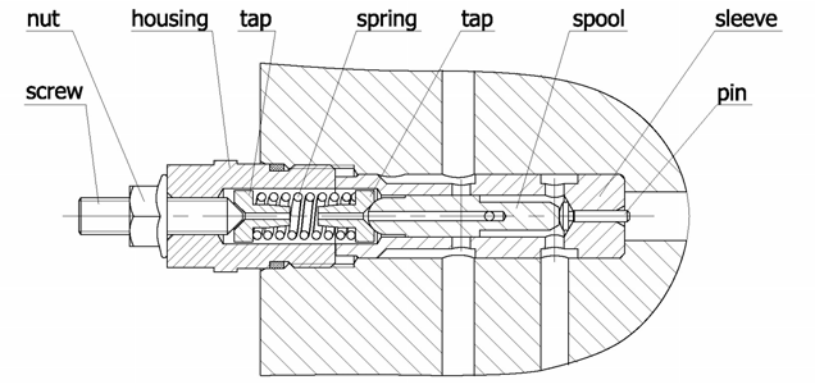
The cut-off valve's functioning is based on regulating principle. The pressure in the delivery pumping line increases up to the given level and the valve spool moves and connects the control line with drain line. Upon that the control line pressure falls to the level of drain line pressure causing the return of servo piston into zero position, therefore the working volume is reduced to zero. The orifice separating charging and control lines doesn't allow charging line pressure fall to the level of drain line pressure.

Cut-off valve's pressure setting should be lower at 10…30bar than pressure relief valve's pressure setting.



The cut-off valve prevents the pressure relief valves' reaction (operation) in speed–up and slowdown, excluding overheating of the hydraulic system as a result of pressure relief valves' operation. The pressure relief valves are opened only at pressure jumps, therefore the heat releases at a minimum level as the period when the valves are opened is short.

Cut-off Valve Structure:



● Auxiliary Mounting Pads

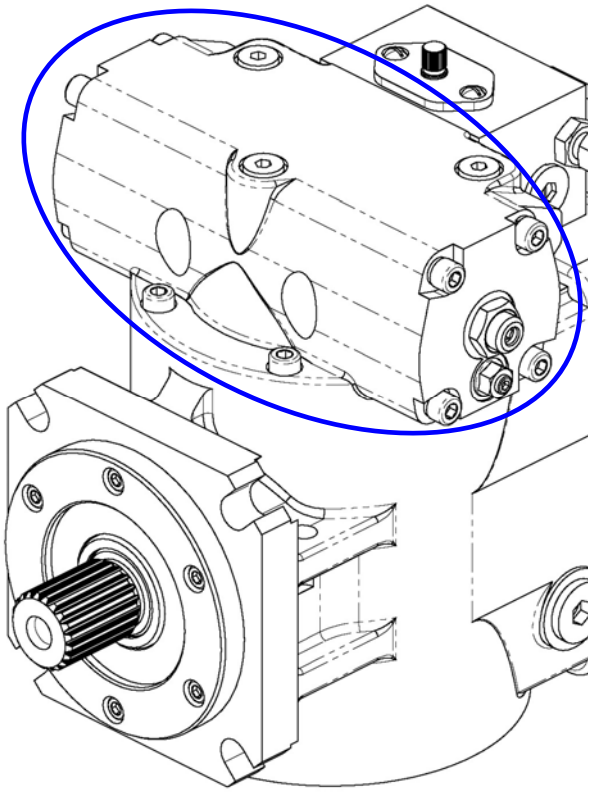
The tandem function is available on every type of series 416 pumps. Tandem function is realized by installing the auxiliary mounting pad on the end cap of the pump and using splined bushings with necessary type of splines.

● Filtration.

There are 2 types of working fluid filtration for series 416 pumps. Using outer suction filter, installed in the suction line of charge pump. The parameters and type of filter are defined by the consumers. Using pressure filter, installed on the end cap of the pump, in the pressure line of charge pump. Filter is an integral part of the pump. The parameters and type of filter are defined by producer.

● Servo Regulator.

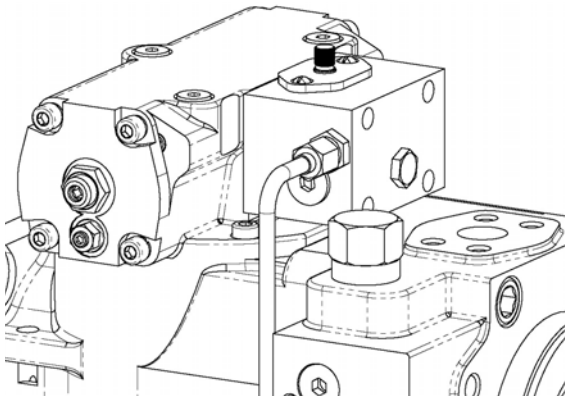
Servo regulator serves to convert the input hydraulic signal delivered from control mechanism into the intense servo hydraulic signal controlling the angle of pump's swash plate.
Servo piston, installed in the iron housing is the main component of servo regulator.
Servo piston delivers the effort to the swash plate through sliding block, moving freely in the servo piston's channel. Servo piston has the mechanical feedback to the spool of control mechanism.
Servo regulator enables the axis, springs and taps group, installed on the axis. In case of no-signal from control mechanism the springs return the servo piston into the initial position corresponding to zero delivery of the pump. The initial position of servo piston (and zero delivery of central pump) is defined by the axis position. The axis has threaded joint with one of the side covers of servo regulator. The position of axis is fixed by the screw.



Working volume limitation.
The limit screw is installed on each side cover of servo regulator in order to limit the maximum working volume. The maximum possible working volume of the pump is adjusted by limit screws. The working volume in each direction may be limited to zero.

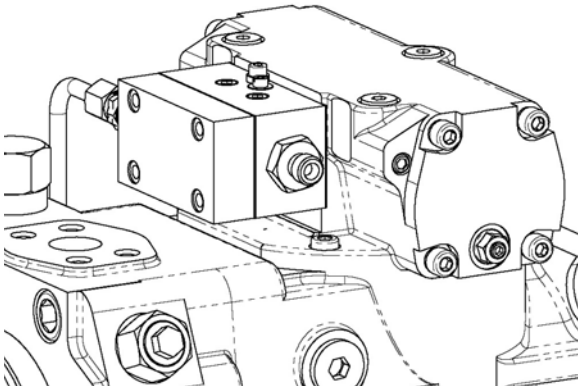
● Control Mechanisms.

● Proportional Mechanical Servo Control.



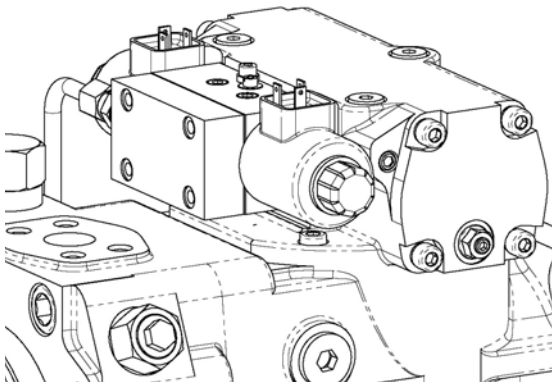
Servo control mechanism serves to convert the basic mechanical signal into intense servo hydraulic signal by servo regulator which angles the swash plate (±20º) with linear scaling of working volume corresponding to the special position of the control lever. The proportionality of swash plate angle to the control lever angle is provided by mechanical feedback between servo piston and servo control mechanism.

● Proportional Hydraulic Control.



Mechanism of hydraulic control serves to convert the input hydraulic signal into the intense servo hydraulic signal by servo regulator, controlling the angle of pump's swash plate.
The spool of control mechanism controls the servo piston directly and has the mechanical feedback to it.
The feedback provides the angle of swash plate proportionally to the hydraulic signal (control pressure) variance.

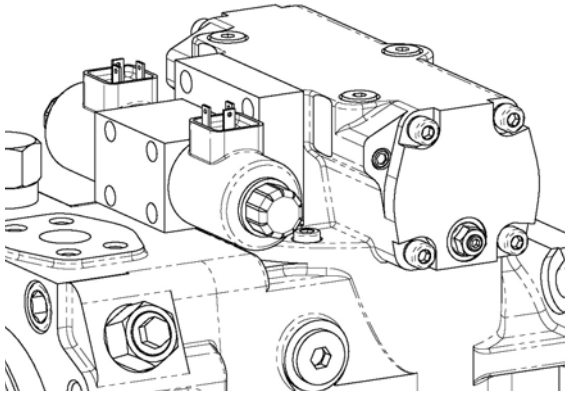
● Proportional Electro Control.



Mechanism of proportional electro control is similar to mechanism of proportional hydraulic control. Instead of hydraulic signal the electric signal 12 and 24V is used.
Electric PWM signal effects on 2 proportional electric solenoids which convert the signal into the mechanical effect of control spool moving. Therefore, mechanism of electro control converts the electric PWM signal into the hydraulic control signal by servo piston.

The spool of electro control mechanism is connected to the servo piston by mechanical feedback.
The feedback provides the swash plate angle proportionally to the electric PWM signal variance.

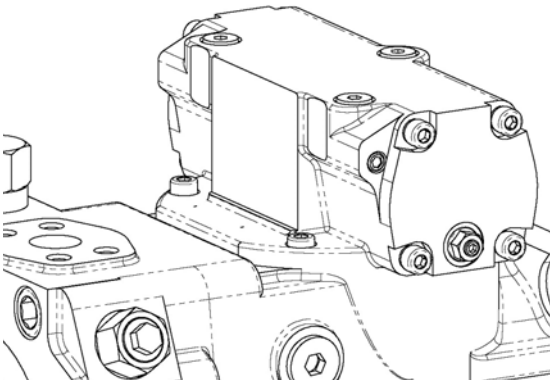
● 3 Position Discrete Electro Control.



The control mechanism is the electro-driven sleeve valve. During signal 12V or 24V sending to one of the electric solenoids the spool moves from the initial position to the max position turning the pressure of servo control into the appropriate servo piston's cavity. Servo piston angles the swash plate of the pump to the maximum angle.
Deenergizing the control signal on the electric solenoid the spool returns back to the initial neutral position.

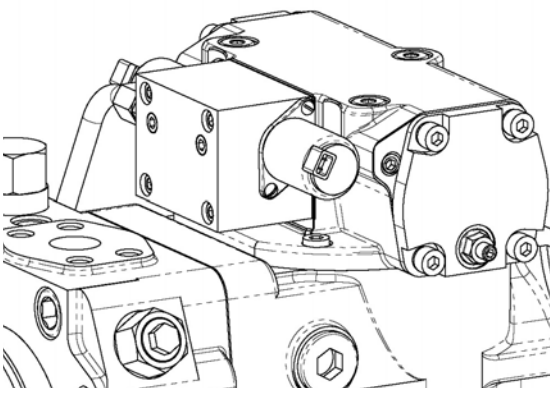
● Proportional Hydraulic Control without Feedback.

The control hydraulic signal effects the servo piston which angles the swash plate.
The angle of swash plate is proportional to the rate of hydraulic control signal only in case of constant pressure in the power line. When the hydraulic drive loading changes, the scheme of control changes too and the proportionality stays up.



● Proportional Electro Control without Feedback.

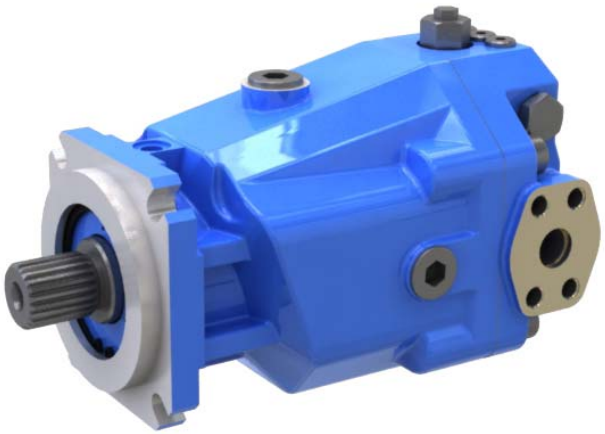
The control mechanism is based on 2 proportional pressure reducing valves with electro control. Each valve is installed in the control line of servo piston.
Getting the 12V or 24V signal the valve regulates proportionally the pressure value of servo control which effects the servo piston.
The angle of swash plate is proportional to the electric PWM signal rate only in case of constant pressure in the power line. When the hydraulic drive loading changes, the scheme of control changes too and the proportionality stays up.



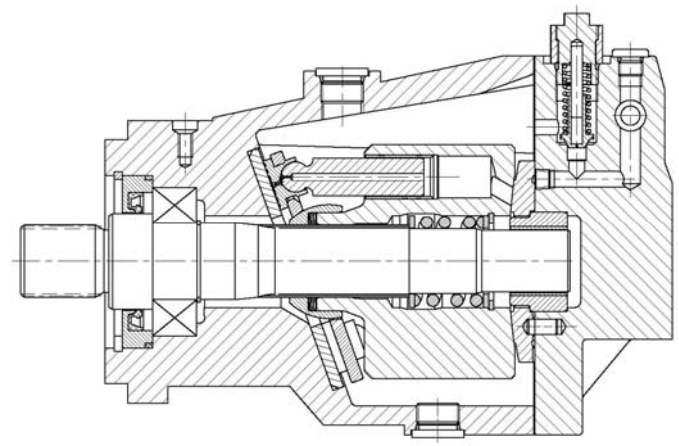
● Series 406 Hydraulic Motors. Basic Components.

All series 406 hydraulic motors are designed and meant for closed loop hydraulic systems.

Series 406 hydraulic motor. General view



Series 406 hydraulic motor. Sectional view



Fixed displacement axial piston swash plate hydraulic motors. The hydraulic motors convert the energy of working fluid into the mechanical energy of shaft rotation. The direction of shaft rotation is defined by the direction of working fluid flow. The shaft speed is defined by the volume of supplied fluid. The torque on the motor's shaft is defined by working fluid pressure.
Hydraulic motors are done in iron housings. Round valve plate and steel embronze cylinder block are applied in the pumping unit of hydraulic motor. They allow to boost the maximum working pressure and to increase the resource.
The loop flushing valve is installed into the end cap of hydraulic motor.

All connection dimensions are done according to ISO/SAE standards.

● Components.

Hydraulic motor consists of the following basic components:
- main motor;
- end cap.

● Main Motor.

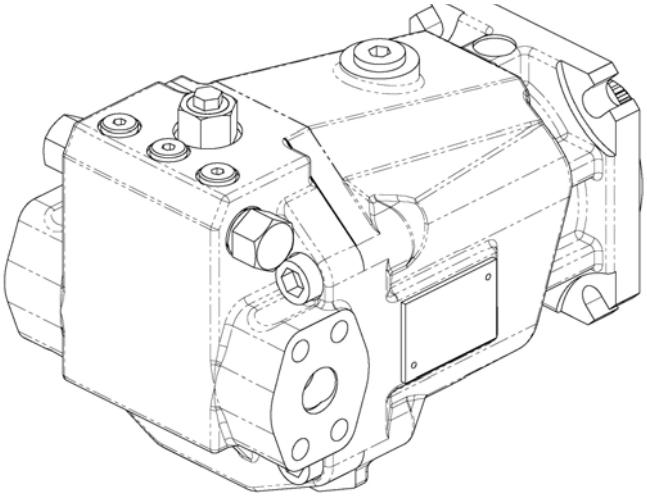
The main hydraulic motor has the iron housing in which the following parts are located:
- shaft, coming through the motor. The front support of the shaft is a roller bearing, fixed in the housing. The end support of the shaft is a sliding bearing, fixed in the end cap.
- pumping unit of hydraulic motor, driving through splined joint of cylinder block and shaft. Piston heels of the pumping unit are retained to the inclined support in the housing and they slide on it during pumping unit rotation.
- seal plate, fixed in the motor's housing at mounting flange side. The seal is installed in the seal carrier.

● End Cap.

Different types of end caps are applied in the series 406 hydraulic motors.

End cap includes:
- loop flushing valve
- purge relief valve

End cap type defines the configuration of high pressure lines' connection ports;

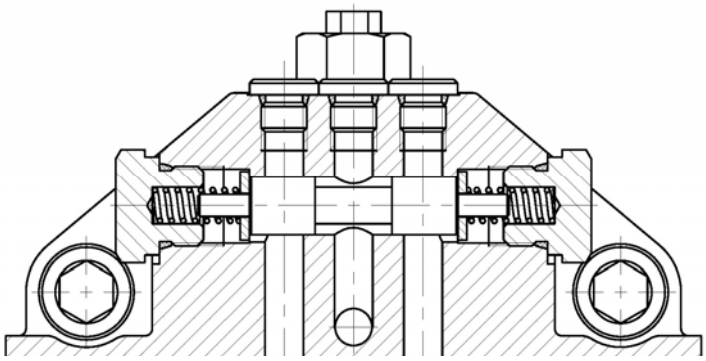


WARNING! Removing of the end cap cancels the motor warranty.

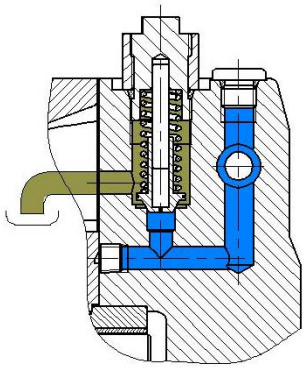
● Loop Flushing Valve and Purge Relief Valve.

The loop flushing valve is built into the end cap of hydraulic motor. The construction and operating principles of loop flushing valve are showed at the picture.
The spool serves to assist fluid changeout in the power tubes to provide productive working temperature range in the hydraulic system and the constant opportunity of closed circuit cleaning. Getting to the insignificant pressure fall at its ends the spool effects bushing, compresses spring and displaces aside.
In this case the lower pressure line (drain tube) together with the drain line connects to the housing of hydraulic motor through purge relief valve. The springs of spool are adjusted by plugs.

Loop Flushing Valve Sectional View



Purge Relief Valve Sectional View



The purge relief valve serves to support the charge pressure in hydraulic system when the loop flushing valve operates.

Getting to the adjusting pressure the effort on the edge of the valve compresses spring and connects bleeding line together with drain line through loop flushing valve supporting the charge pressure. The setting of purge relief valve is made by spring compressing with the help of valve thread casing.

Features.

● Main Features.

Construction:	Connection ports of power tubes:
Variable displacement axial piston swash plate pumps and fixed displacement axial piston swash plate hydraulic motors.	SAE 3000 psi SAE 6000 psi

Mounting flanges:	Direction of shaft rotation:
- pumps: SAE C, 4 bolts SAE C-C, 6 bolts SAE D, 4 bolts SAE D-D, 6 bolts	- pumps: clockwise or counterclockwise - motors: reverse
- motors: SAE C, 4 bolts	

Recommended orientation of installation:
- pump: control mechanism is located above or on the side. - motor: any orientation

Hydraulic lines connection ports: See «Pressure Control»

● Technical Features.

Variable displacement pumps:

		416.0.71	416.0.90	416.0.110	416.0.125
Displacement	ccm/rev	71	90	110	125
Shaft speed - minimum - nominal - maximum - peak	rpm	 500 2000 3050 3300	 500 2000 3050 3300	 500 1500 3000 3200	 500 1500 3000 3200
Torque at n_{nom}, V_{max}, P_{max}	Nm	509	643,4	787,1	893,2
Power at n_{nom}, V_{max}, P_{max}	kW	154	194,8	234,4	266,1
Weight	kg	67	67	78,5	78,5

Fixed displacement hydraulic motors:

		406.0.71	406.0.90	406.0.110	406.0.125
Displacement	ccm/rev	71	90	110	125
Shaft speed - minimum - nominal - maximum - peak	rpm	 2000 3050 3300	 2000 3050 3300	 1500 3000 3200	 1500 3000 3200
Torque at n_{nom}, V_{max}, P_{max}	Nm	406,8	515,7	630,2	716,2
Power at n_{nom}, V_{max}, P_{max}	kW	136,8	173,4	208,4	236,8
Weight	kg	40	40	46,2	46,2

- Hydraulic Parameters.

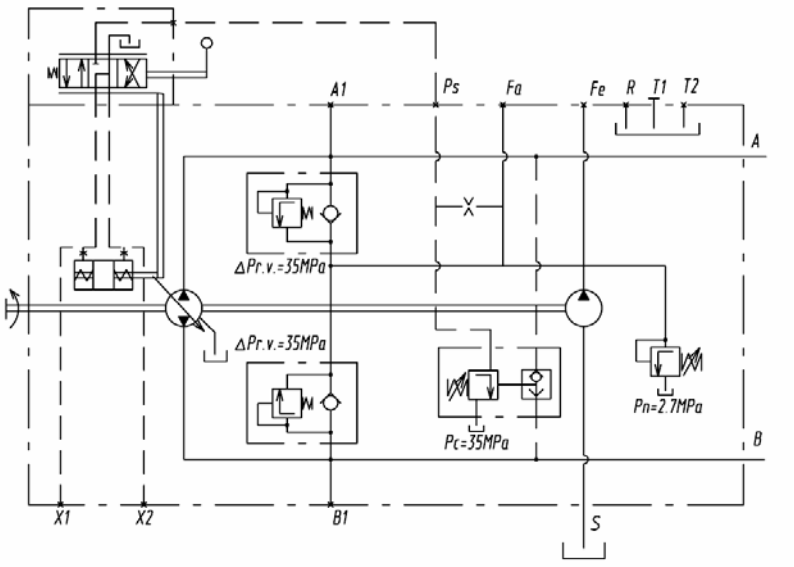
Working pressure (differential pressure):		Power fluid temperature:	
Maximum working pressure	400 bar	Max. constant temp. Max. peak temp. (short-time)	+75ºC +100ºC
Maximum peak pressure	450 bar	Min. short-time temp. (cold start)	- 40ºC

Pressure at the charge pump inlet (absolute):		Coefficient of power fluid kinematic viscosity:	
Min. working pressure	0,8 bar	optimal (constant)	20-35 mm^2/s (cSt)
Min. short-time pressure (t<5min) (cold start)	0,5 bar	Max. starting Min. short-time	1500 mm^2/s (cSt) 10 mm^2/s (cSt)

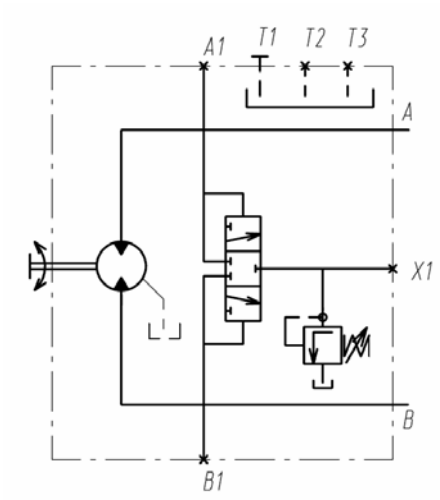
Drain pressure:		Power fluid cleanliness:
Max. working pressure	2,5 bar	12 class of national standard 17216-71
Max. short-time pressure (t<5min)	5 bar	18/15 class of ISO/DIN 4406

See the recommended working fluids and their basic characteristics in the catalogue of products or on the web-site: www.psm-hydraulics.com

- Hydraulic Schemes.



Variable displacement pump with proportional servo control

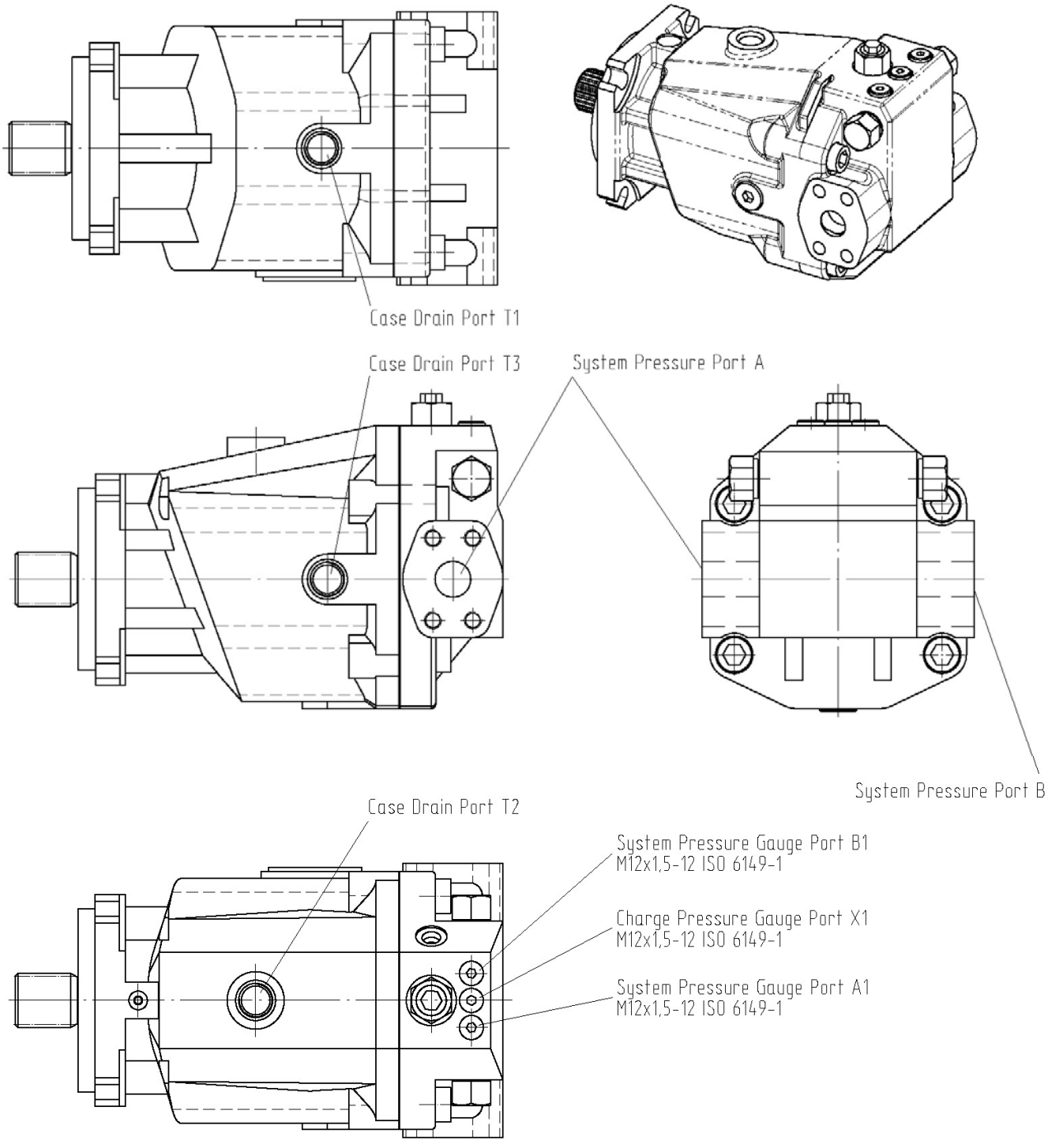


Fixed displacement hydraulic motor

Pressure Control.
Pressure control ports locations and their description.
The following procedures may be done applying the standard set of tools and keys. In case when a special tool is required its code is pointed according to the rules of PSM-Hydraulics.
The applying gages and other measuring tools should be checked and calibrated.

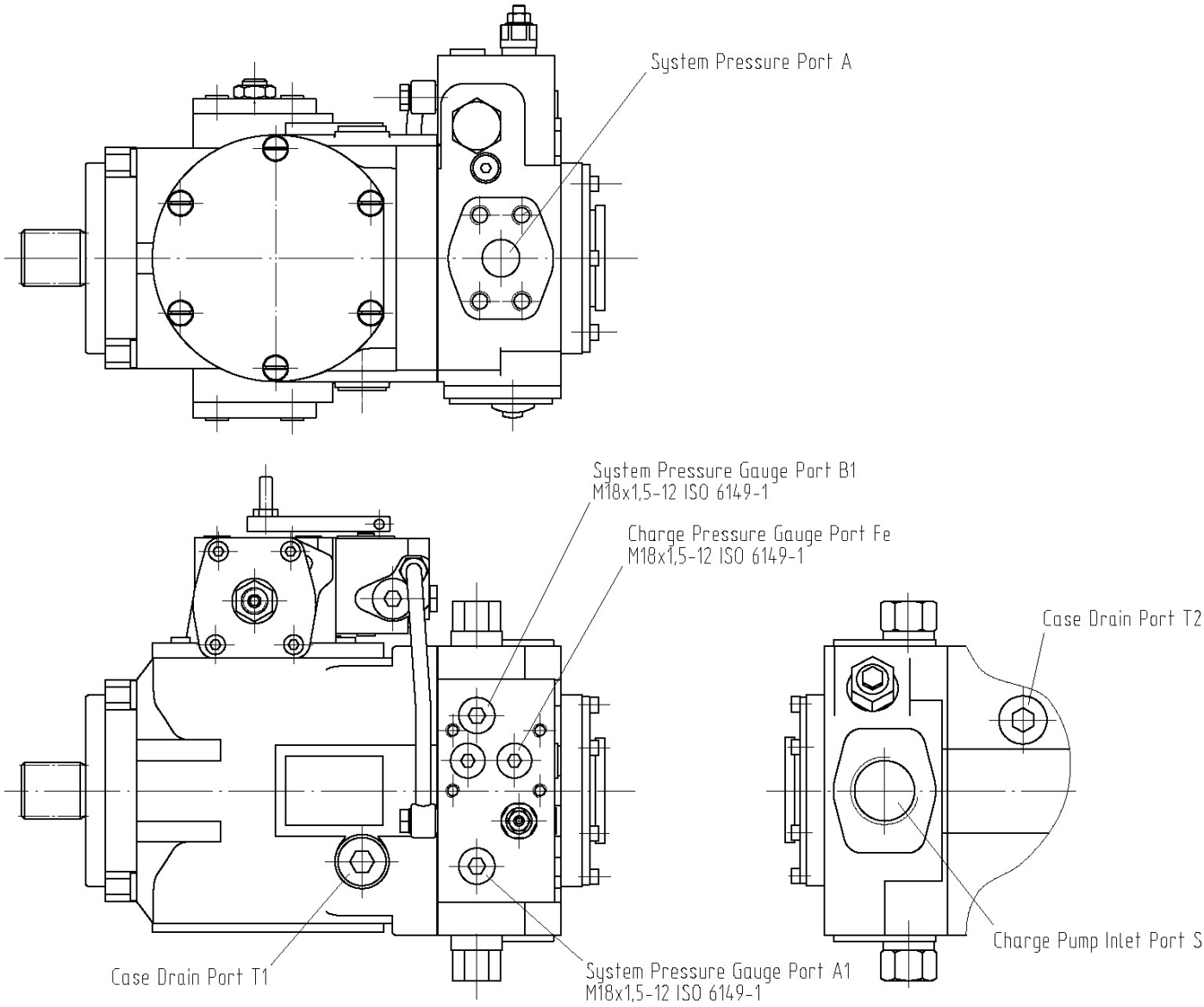
● Fixed Displacement Hydraulic Motor.

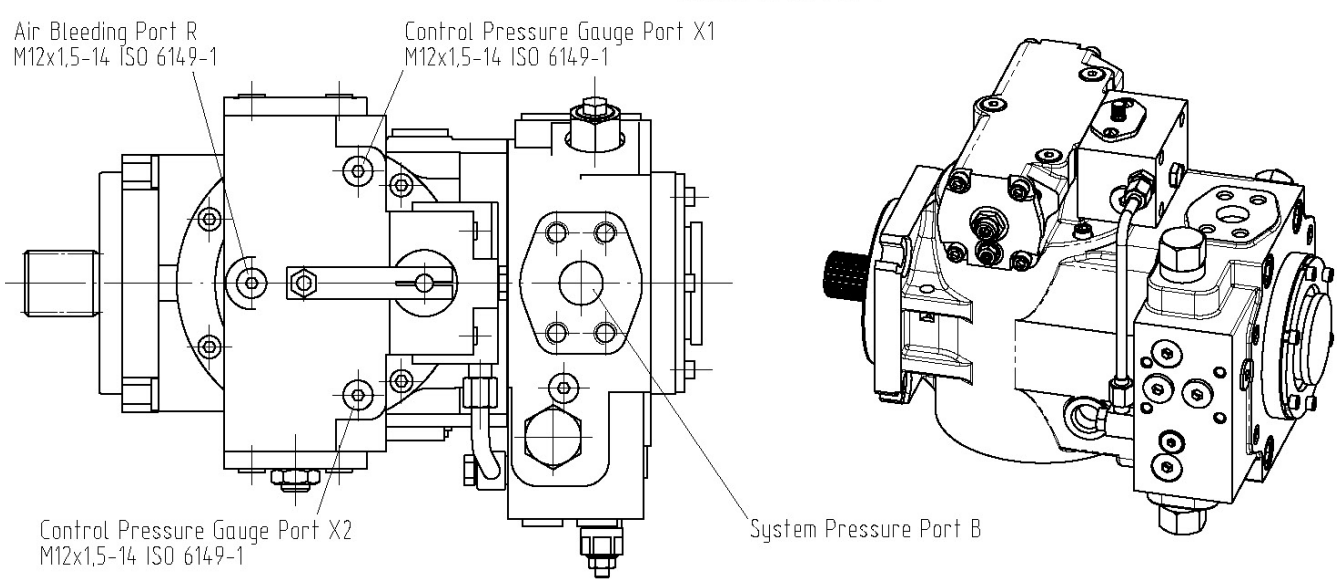
Port	Function	Gauge Size and Fitting	
A1, B1	System Pressure	M12x1,5-12 ISO 6149-1	
X1	Charge Pressure	M12x1,5-12 ISO 6149-1	
T1, T2, T2	Case Pressure	M22x1,5-15 ISO 6149-1	NN (Ordering code **G** "Special features")
		7/8-14UNF-2B ISO 11926-1	IN (Ordering code **G** "Special features")
		M22x1,5-15 DIN 3852-1	RN (Ordering code **G** "Special features")


Case Drain Port T1
Case Drain Port T3
System Pressure Port A
System Pressure Port B
Case Drain Port T2
System Pressure Gauge Port B1
M12x1,5-12 ISO 6149-1
Charge Pressure Gauge Port X1
M12x1,5-12 ISO 6149-1
System Pressure Gauge Port A1
M12x1,5-12 ISO 6149-1

- Variable Displacement Pumps

Port	Function	Gauge Size and Fitting	
A1, B1	System Pressure	M12x1,5-12 ISO 6149-1	
Fe	Charge Pressure	M12x1,5-12 ISO 6149-1	
X1, X2	Control Pressure	M12x1,5-12 ISO 6149-1	
R	Air Bleeding (Case Pressure)	M12x1,5-12 ISO 6149-1	
T1, T2, T2	Case Pressure	M22x1,5-15 ISO 6149-1	NN (Ordering code **G** "Special features")
		7/8-14UNF-2B ISO 11926-1	IN (Ordering code **G** "Special features")
		M22x1,5-15 DIN 3852-1	RN (Ordering code **G** "Special features")


System Pressure Port A
System Pressure Gauge Port B1
M18x1,5-12 ISO 6149-1
Charge Pressure Gauge Port Fe
M18x1,5-12 ISO 6149-1
Case Drain Port T2
Charge Pump Inlet Port S
Case Drain Port T1
System Pressure Gauge Port A1
M18x1,5-12 ISO 6149-1


Air Bleeding Port R
M12x1,5-14 ISO 6149-1
Control Pressure Gauge Port X1
M12x1,5-14 ISO 6149-1
Control Pressure Gauge Port X2
M12x1,5-14 ISO 6149-1
System Pressure Port B

Trouble-Shooting.

● The list of the main failures of series 416 pump and series 406 hydraulic motor. Recommendations on trouble-shooting.

Zero unavailability.

"mechanical zero" is not adjusted on the swash plate of the pump	To adjust zero with the help of axis on the servo regulator
Neutral on the control mechanism is not adjusted	To adjust neutral on the control mechanism
Control mechanism failure	Change the control mechanism
Servo regulator failure	Change the pump

Flash heat of the hydraulic system. Hydraulic system overheating.

Low level of oil in the hydraulic reservoir.	Eliminate the cause of oil bleeding. Top up the oil into the hydraulic reservoir
Oil cooler failure	Clean, repair or change oil cooler
Low level of pressure relief safety valves adjustment	Adjust the safety valves to the higher level
Excessive load of HST	Lower the operating conditions of HST

Low charge pressure. Charge pump heating.

Filter in the suction line is choked	Change the filter element
The suction line of the pump is choked	Eliminate the choking
Charge pressure valve is not adjusted	Adjust the charge pressure valve
Charge pressure valve failure	Change the valve
Low level of oil in the hydraulic reservoir	Eliminate the cause of the oil bleeding. Top up the oil into the hydraulic reservoir
Air remains in the suction line	Eliminate the leakage of suction line
Charge pump failure	Change the charge pump

Charge pressure unavailability.

Charge pump failure	Change charge pump
Charge pressure valve failure	Change valve
Central pump drive failure	Repair the drive of central pump

Unwanted sounds during hydrostatic transmission operation.

Air remains in hydraulic system	Eliminate the leakage of hydraulic system connections
Pump or motor internal faults	Change pump or hydraulic motor

HST operates only in one direction.

Control mechanism failure	Change the control mechanism
Orifice is choked in the control line	Clean the orifice
One of the check valves is defective	Change the check valve
Pressure relief safety valve is choked	Clean the valve
Pressure relief safety valve failure	Change the valve
Internal faults of the pump	Change the pump

HST doesn't operate in both directions.

Low level of oil in the hydraulic reservoir	Eliminate the cause of oil bleeding. Top up the oil into the hydraulic reservoir
Control mechanism failure	Change controlling mechanism
Orifice in control lines is choked.	Clean the orifice
Charge pump failure	Change the charge pump
Charge pressure unavailability	See above
Clogged intake filter	Change the filter element
Check valves failure	Change the check valves
Cut-off valve failure	Change the cut-off valve
Pressure relief safety valves failure	Change the valves
Internal fault of the pump	Change the pump
Internal fault of the motor	Change the hydraulic motor

Low-speed starting and delays.

Air remains in hydraulic system	Eliminate the leakage of the hydraulic system connections
Low charge pressure	See above
Orifice are choked	Clean the orifice
Defective details in the pumping unit of pump and hydraulic motor	Change the pump or hydraulic motor

Low efficiency of hydrostatic transmission.

Low level of oil in hydraulic reservoir	Eliminate the cause of oil bleeding. Top up the oil into the reservoir
Rotary Group wear	Change pump or hydraulic motor
Low charge pressure	See above

Fluctuations of pump supply flow in case of controlling unavailability.

Charge pressure valves are adjusted similarly	Adjust the charge pressure valves on the pump and hydraulic motor correctly
Zero of hydraulic pump swash plate (cradle) is not adjusted	Change the pump

Leak flow on the shaft of the product.

Sealing failure	Change the seal
Defective spindle on the shaft of the pump	Change the shaft of the pump and the sealing

Checking and Adjusting.
Checking and adjusting of pumps and hydraulic motors are described in the given section. It is necessary to read thoroughly the given section before starting the after-sales service of hydrostatic transmission's components. Follow the above-mentioned sections if necessary in order to define the correct port and its parameters for connecting the gauges.

- Series 416 pumps

- Charge Pressure Valve

Checking the charge pressure setting

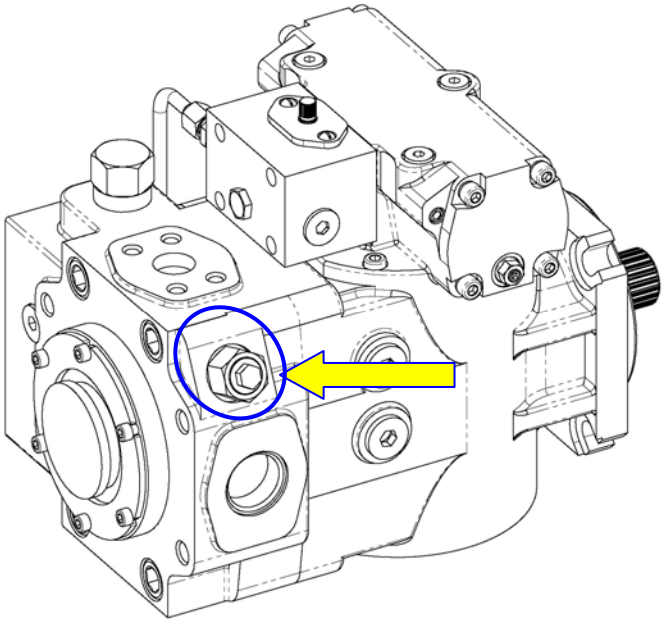
For checking the charge pressure setting, connect the manometer to the charge pressure gauge port **Fe** on the end cap of the pump.
The limit of measured pressure of the manometer should be up to 60bar and not lower.
Connect the other manometer to the drain pressure gauge port in the pump.

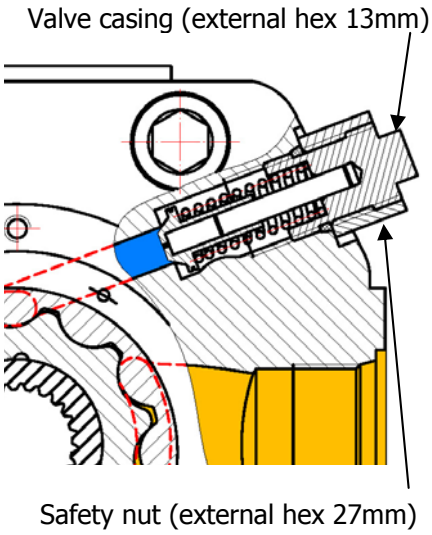
» Activate the pump in the neutral delivery mode and measure the charge pressure.

WARNING! When the pump is not in the neutral delivery mode the manometer shows the charge pressure setting of purge relief valve on the hydraulic motor.

The charge pressure is a difference of gauges reading, charge pressure - drain pressure. The charge pressure is up to 27±1 bar upon 1500 rpm of the pump's shaft and working fluid temperature in the drain cavity of the pump +45…50ºC.

Charge pressure setting.





The charge pressure is adjusted by charge pressure valve casing.

» Ease off the lock nut.
» Set the required charge pressure by turning the valve casing by the wrench.

Valve casing clockwise rotation increases the charge pressure. One complete revolution of charge pressure valve casing increases the pressure up to 4±0,5bar (approx).

» The pressure should be controlled by the manometer.
» Torque the lock nut= 50Nm, holding the valve casing by the wrench.

• Pressure Relief Safety Valves.

Checking the system pressure setting.

Connect the two manometers to the system pressure gauge ports **A1** and **B1** on the end cap of the pump for checking the system pressure.
It is admissible to connect the manometers to the system pressure gauge ports **A1** and **B1** on the end cap of hydraulic motor.
The limit of measured pressure of the manometer is to be up to 600bar and not lower.
Connect the manometer to the charge pressure gauge port **Fe** on the end cap of the pump.
The limit of measured pressure of the manometer is to be up to 60bar and not lower.

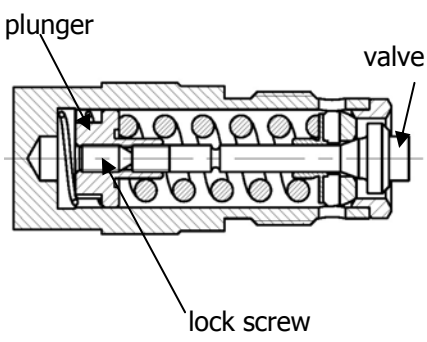
WARNING! Exclude the cut-off valve out of operation in case of its availability in the construction of the pump.
In order to exclude the cut-off valve:
- ease off the lock nut on the cut-off valve;
- turn the adjusting screw of the valve against the clock on two complete revolutions.
One complete revolution corresponds to the changing of pressure setting up to 60±5bar.

» Block the output shaft of the hydraulic motor.
» Activate the pump. Set the shaft speed on the pump up to 1500 rpm.
The temperature of working fluid in the drain cavity of the pump should be up to +45…50ºC.
» Set the pump control signal slowly.
» Control the pressure relief safety valve setting with the help of manometers.
» Repeat the procedure for the second system line (second pressure relief safety valve).

The pressure relief safety valves' operation setting is the difference of gauges reading, pumping pressure - charge pressure.

Pressure Relief Safety Valve Adjustment

» Remove the valve from the pump.
» Get the internals out of the valve bushing.
» Ease off the lock screw (internal hex 3mm).



» Set the required pressure holding the valve by the wrench (external hex 10mm), turning the plunger (external hex 14mm).
» Torque the lock screw = 6±0,5Nm.

The plunger's clockwise turning increases the pressure setting of the valve. One complete revolution of the plunger increases the pressure up to 40±5bar (approx).

» Install the spring of return valve into the valve bushing.
» Install the internals into the valve bushing.

» Install the valve seat.
» Install the pressure relief safety valve into the end cap of the pump. Torque the valve 200±15Nm.

● Cut-off Valve.

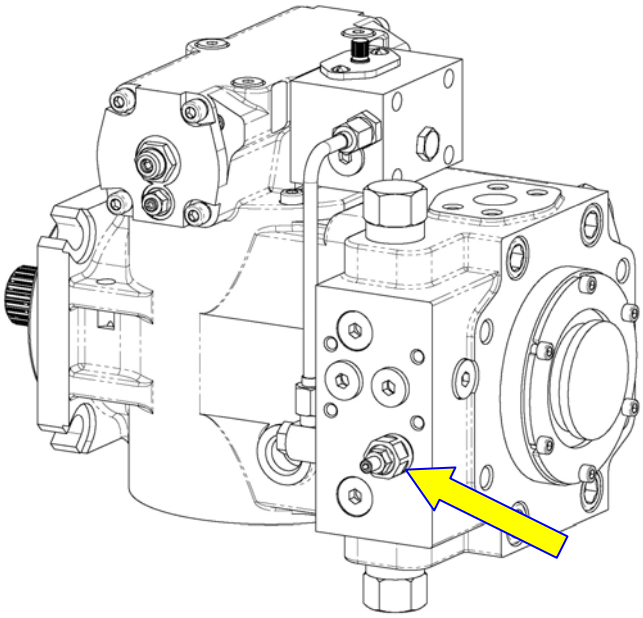
Checking the cut-off pressure setting.

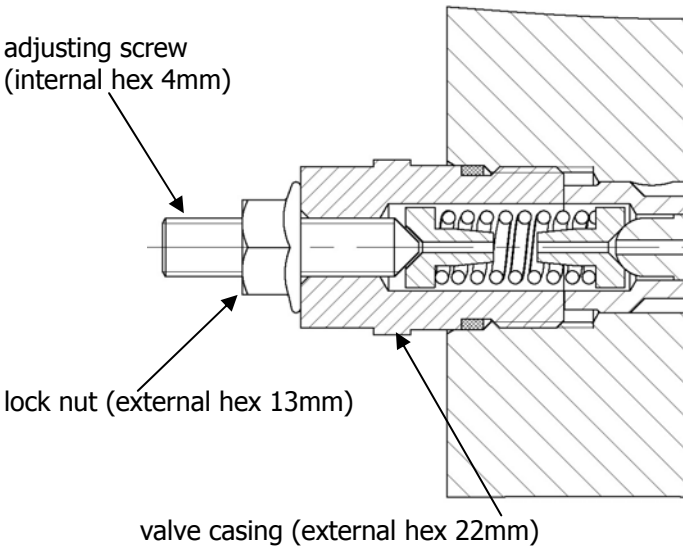
Connect the two manometers to the system pressure gauge ports **A1** and **B1** on the end cap of the pump for checking the cut-off pressure.
It is admissible to connect the manometers to the system pressure gauge ports **A1** and **B1** on the end cap of hydraulic motor.
The limit of measured pressure of the manometer is to be up to 600bar and not lower.
Connect the manometer to the charge pressure gauge port **Fe** on the end cap of the pump.
The limit of measured pressure of the manometer is to be up to 60bar and not lower.

» Block the output shaft of the hydraulic motor.
» Activate the pump. Set the shaft speed on the pump up to 1500 rpm.
The temperature of working fluid in the drain cavity of the pump should be up to +45…50ºC.
» Set the pump control signal slowly.
» Control the pressure setting of cut-off valve with the help of monometers.
» Repeat the procedure for the second pumping line.

The pressure of cut-off valve's operation setting is the difference of gauges reading, pumping pressure - charge pressure.

Cut-off pressure setting.





The cut-off pressure is set by adjusting screw on the cur-off valve.

» Holding the cut-off valve casing by the wrench ease off lock nut.
» Set the required cut-off pressure by turning the adjusting screw.

The screw's clockwise turning increases the cut-off pressure. One complete revolution of the adjusting screw increases the pressure up to 60±5bar (approx).

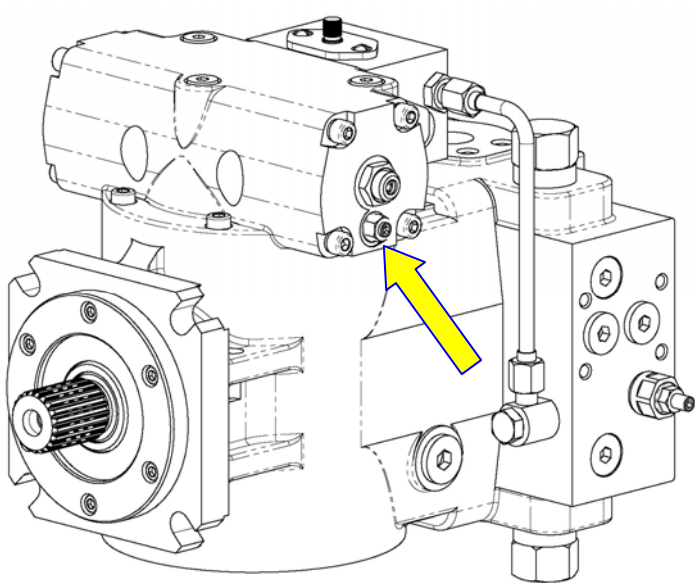
» Control the pressure by the manometer.
» Torque the lock nut = 25Nm holding the adjusting screw by the wrench.

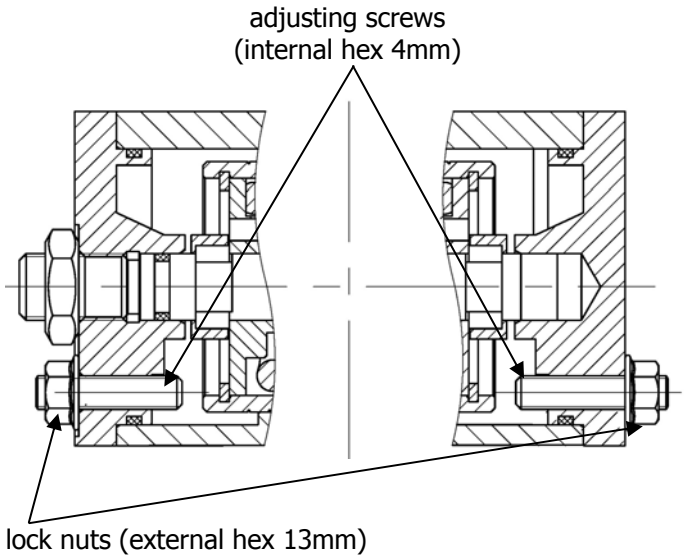
● Adjustment of Displacement Limitation.

Limit screws are installed into servo regulator in order to limit the maximum working volume of the pump.
The maximum working volume (supply) of the pump may be limited on each direction.

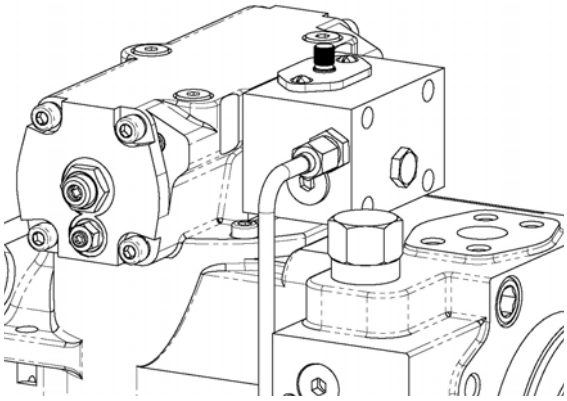
» Ease off the lock nut of adjusting screw.
» Adjust the required working volume by screw turning.
» Torque the lock nut = 25Nm holding the adjusting screw by the wrench.

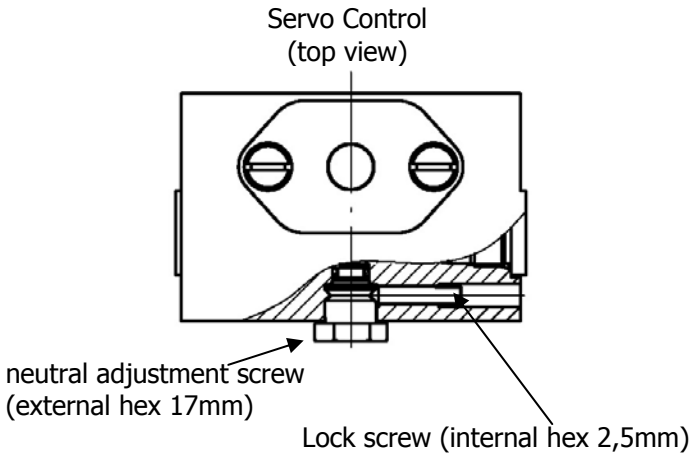
The clockwise turning limits the working volume of the pump. One complete revolution of the screw corresponds to ΔV = 10,4 cm^3/r (approx).





● Proportional Servo Control.
Neutral is set by neutral adjustment screw on the Servo Control.

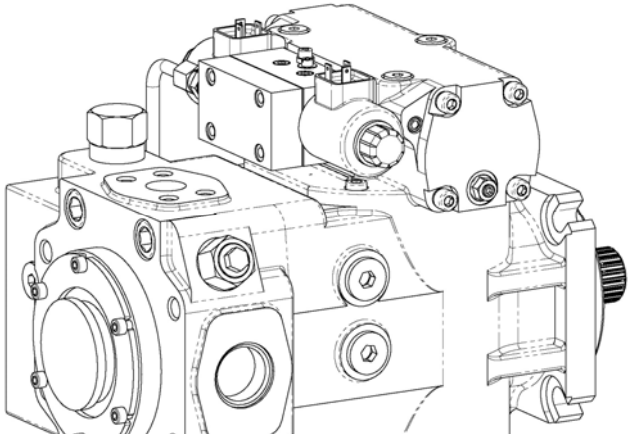


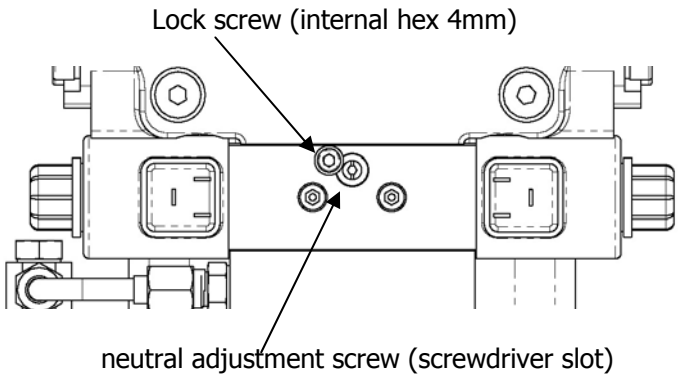


Connect the manometers in order to set neutral on the Servo Control:
- to the control pressure gauge ports **X1** and **X2** of on the servo regulator casing.
- to the charge pressure gauge port **Fe** of on the end cap of the pump.
The limit of measured pressure of the manometers should be up to 60bar.

» Activate the pump. Set the pump's shaft speed up to 1500 rpm.
» Ease off the lock screw.
» Set neutral by turning adjustment screw.
» The setting should be controlled by manometers reading in gauge ports **X1** and **X2**. The readings should be similar.
» Torque the lock screw **=** 6±0,5Nm holding the neutral adjustment screw by the wrench.

● Proportional Hydraulic Control.
Neutral is set by neutral adjustment screw on the Hydraulic Control.

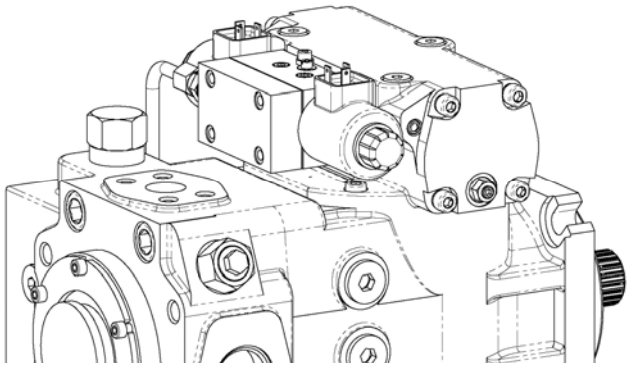


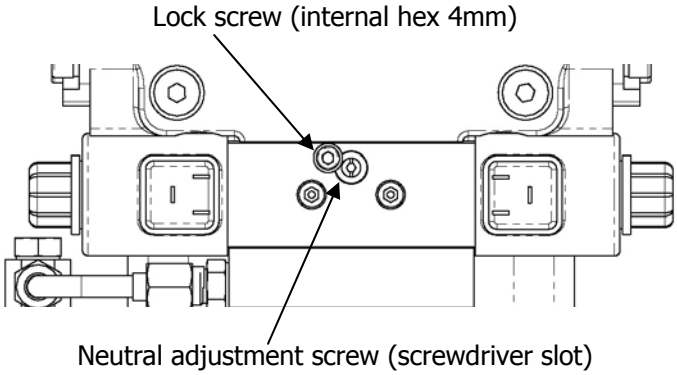


Connect the manometers in order to set zero on the Hydraulic Control:
- to the control pressure gauge ports **X1** and **X2** of on the servo regulator casing.
- to the charge pressure gauge port **Fe** of on the end cap of the pump.
The limit of measured pressure of the manometers should be up to 60bar.

» Activate the pump. Set the pump's shaft speed up to 1500 rpm.
» Ease off the lock screw.
» Set neutral point by turning adjustment screw.
» The setting should be controlled by manometers reading in gauge ports **X1** and **X2**. The readings should be similar.
» Torque the lock screw**=** 6±0,5Nm holding the neutral adjustment screw by the wrench.

● Proportional Electro Control.
Neutral is set by neutral adjustment screw on the Electro Control.

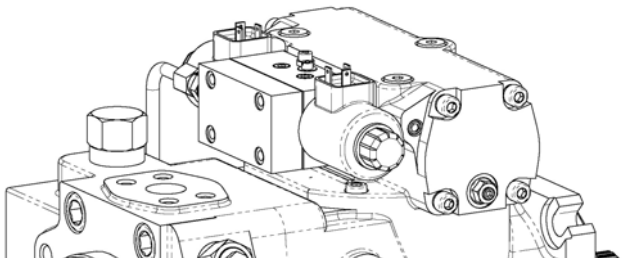




Connect the manometers in order to set zero on the mechanism:
- to the control pressure gauge ports **X1** and **X2** of on the servo regulator casing.
- to the charge pressure gauge port **Fe** of on the end cap of the pump.
The limit of measured pressure of the manometers should be up to 60bar.

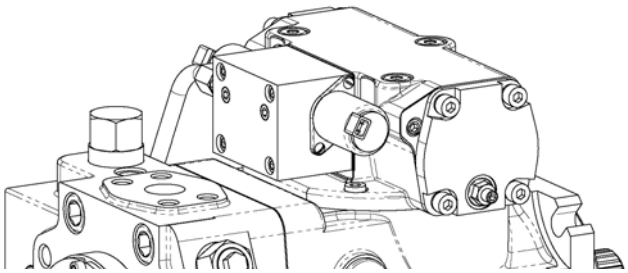
» Activate the pump. Set the pump's shaft speed up to 1500 rpm.
» Ease off the lock screw.
» Set neutral point by turning adjustment screw.
» The setting should be controlled by manometers reading in gauge ports **X1** and **X2**. The readings should be similar.
» Torque the lock screw= 6±0,5Nm holding the neutral setting by the wrench.

● 3 Position Discrete Electro Control



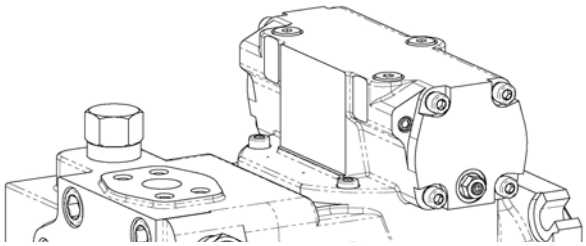
Adjustment and settings are not required.

● Proportional Electro Control without Feedback.



Adjustment and settings are not required.

● Proportional Hydraulic Control without Feedback.



Adjustment and settings are not required.

- Series 406 Hydraulic Motors.

- Purge Relief Valve.

Checking the charge pressure setting.

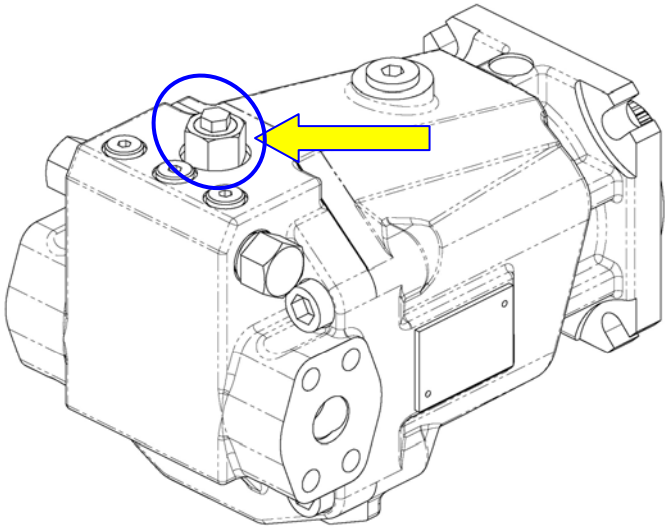
For checking the purge relief valve setting, connect the manometer to the charge pressure gauge port **X1** on the end cap of the motor.
The limit of measured pressure of the manometer should be up to 60bar and not lower.
Connect the other manometer to the drain pressure gauge port in the motor.

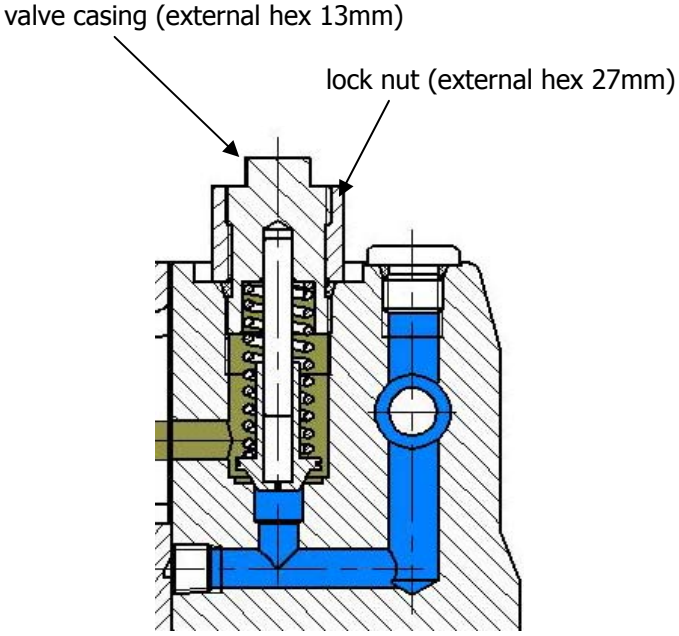
» Activate the supply of working fluid from the pump and measure the charge pressure. The working fluid flow direction is not necessary.

WARNING! When the pump is not in the neutral delivery mode the manometer shows the pressure of charge pressure valve setting on the pump.

The charge pressure is a difference of gauges reading, charge pressure - drain pressure. The charge pressure is up to 23±1bar upon 1500rpm of the pump's shaft and working fluid temperature in the drain cavity of the pump +45…50ºC.

Charge pressure setting.





The charge pressure is adjusted by purge relief valve.
» Ease off the lock nut.
» Set the required charge pressure by turning the valve casing.

Valve casing clockwise rotation increases the charge pressure. One complete revolution of charge pressure valve casing increases the pressure up to 4±0,5bar (approx).

» The pressure should be controlled by the manometer.
» Torque the lock nut = 50Nm, holding the valve casing by the wrench.

Basic Repair Instructions.

The examples of minimum repairs of series 416 pumps and series 406 hydraulic motors are described in the given section.
The following procedures may be done directly on the equipment except shaft and sealing replacement and do not require pump or hydraulic motor disassembling.

For more complicated repair contact the producer or authorized service centers.

All repair works except shaft sealing replacement in hydraulic units should be agreed together with producer or authorized suppliers or authorized service center in order to keep the hydraulic unit's warranty.

Outwatch the sealing elements while making the repair procedures:
- rubber rings and seal housings;
- cutting edges of seals and shaft surface;
- valves' gates working surfaces and responsive edges done in the hydraulic units' housings.

In order to avoid failures during assembling lubricate the seal rings and their seats in the housings before hydraulic components installation.

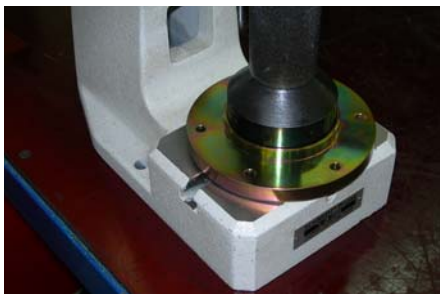
Avoid dirt contamination in the interior cavities and passages of hydraulic units.
Before dismantling any component of pump or hydraulic motor clean this component and surfaces around thoroughly. Use cleaning fluids, dry clean rag and pressed air.

Use only new seal rings and layings in order to prolong the mechanical life of the pump and hydraulic motor. Always change all the general mechanical rubber goods and layings to the new parts even if the faults are not inspected out in any component of pump or hydraulic motor.

- Basic Repair of Pump.

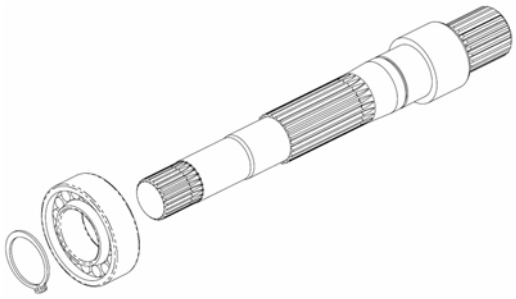
- Pump shaft and shaft sealing replacement.

» Unscrew seal cover plate's six screws (internal hex 6mm).
» Take the seal cover plate out.



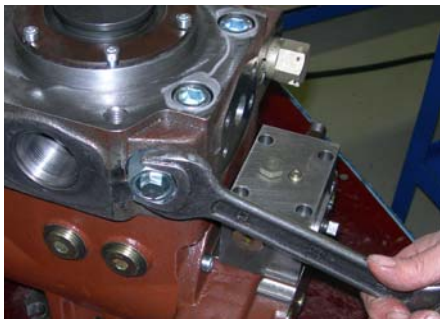
» Replace the seal for the new one.
» Replace the seal ring of the seal cover plate for the new one.
» Check the working area of shaft and seal cover plate surface contact. Replace the shaft in case of wearing.
» Install the seal cover plate in case when the shaft replacement is not necessary.

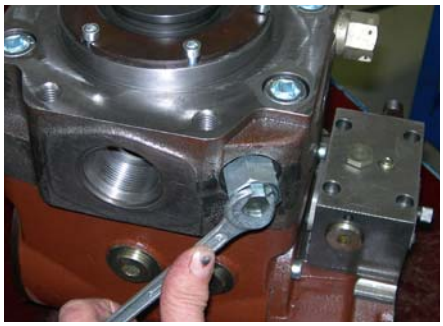
» Take the ring out.
» Take the shaft out of the pump.



» Take the locking ring off the shaft.
» Take the roller bearing off the shaft and install it on the new one.
» Install the locking ring on the new shaft.
» Install the shaft assembly into the pump.
» Grease the following parts with working fluid before seal cover plate installation:
- shaft surface in the area of seal contact;
- cutting edge of the seal;
- seal ring of the seal cover plate.
» Install the seal cover plate into the pump housing.
» Set the seal cover plate six screws. Torque the screws = 12±2Nm.

● Charge Pressure Valve Replacement.





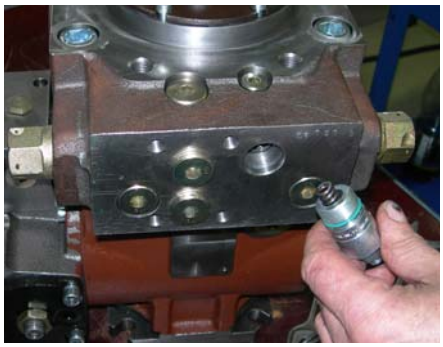
It is recommended to mark the lock nut position relating to end cap of the pump and valve casing before the replacement of charge pressure valve. Install the valve in accord with the mark and set the pressure in case when the charge pressure valve replacement is not required.

» Ease off the lock nut of charge pressure valve (external hex 27mm).
» Turn the charge pressure valve out of the end cap of pump (external hex 13mm).
» Check the sealing edge in the end cap of the pump (seat) for cleanliness and defects.
» Install the new valve. Torque the lock nut of the valve = 50 Nm.
» Adjust the valve.

● Pressure Relief Safety Valve Replacement.

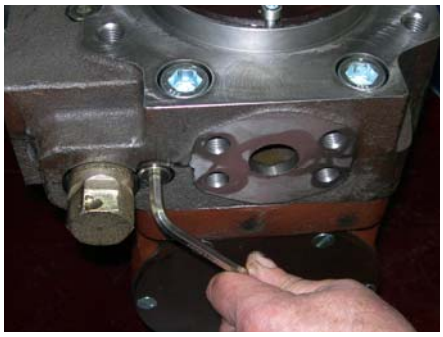
» Take the pressure relief safety valve out of the end cap plate of the pump (external hex 30mm).
» Check the sealing surface in the end cap of the pump for defects.
» Install the new valve into the rear plate. Lubricate the seal rings of the valve before installation.
» Torque the valve = 200±15Nm.

• Cut-off Valve Replacement.

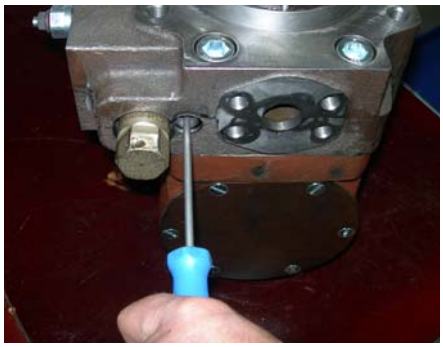


» Turn the cut-off valve out of the end cap of the pump (external hex 22mm).
» Install the new cut-off valve, lubricate the seal ring of the valve and the seat in end cap before installation.
» Torque the valve = 100±10Nm.

• Check Valves Replacement.

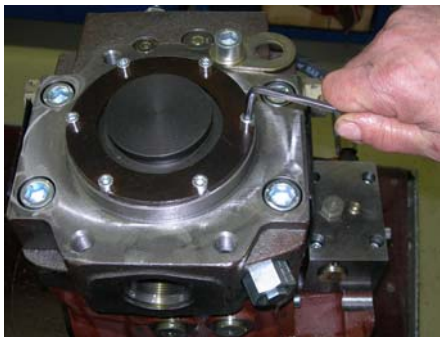


» Take off the plug (internal hex 6mm).



» Turn the check valve out.
» Install the new check valve.
» Set the plug. Torque = 35±3Nm.
» Replace the second valve on the other side.

• Charge Pump Replacement.



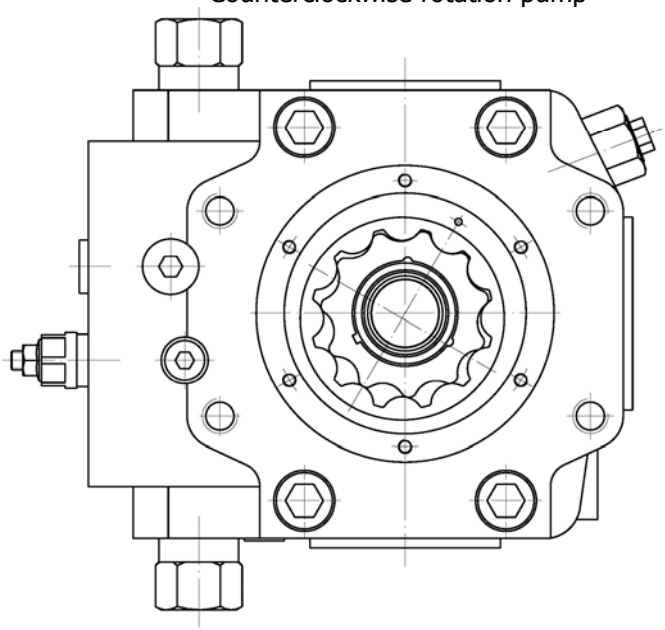
» Unscrew the pressure ring plate's six screws (internal hex 6mm) and take the ring plate of charge pump off.
» Take the cover plate of the charge pump out.
» Take the splined bushing with installed key and gear out.

» Take the gear out.
» Take the ring, spacer and pin out together.

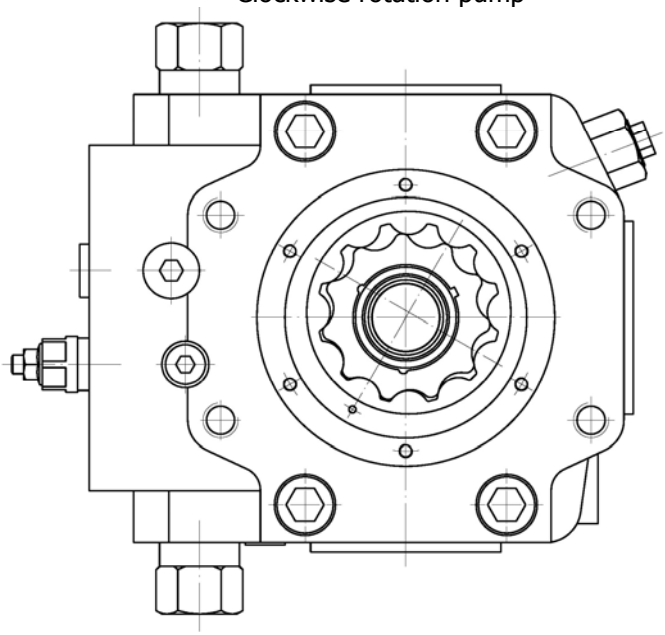
Install the new pump.

WARNING! Do not confuse the pin's location and the direction of charge pump delivery while installing the new gerotor type charge pump. The charge pump parts orientation depending on the direction of central pump's shaft rotation is shown at the picture.

Counterclockwise rotation pump



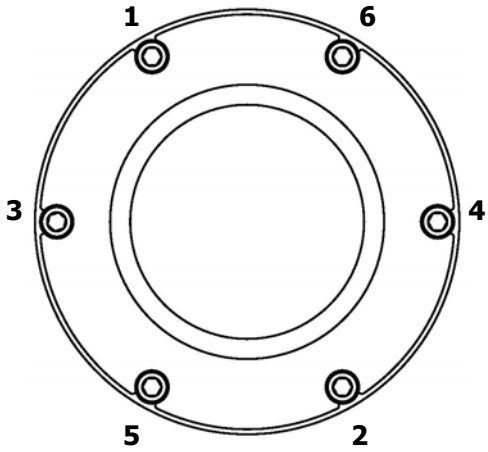
Clockwise rotation pump



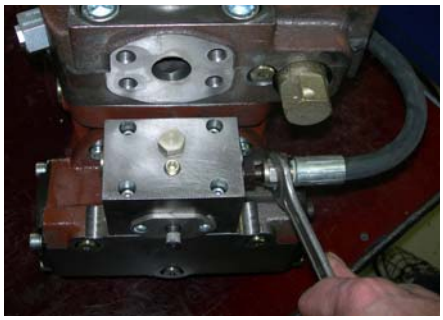
» Install spacer and pin.
» Install the ring.
» Install the key of the new charge pump into the splined bushing. Install the gear on splined bushing.
» Install splined bushing on the shaft of central pump.

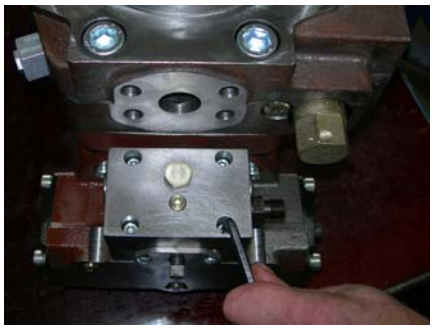
» Install the wheel.
» Lubricate the seal ring on the cover plate of charge pump.
» Install the cover plate of charge pump.
» Install the pressure ring plate and torque the six screws = 8,82 – 9,8Nm.

WARNING!
Hold the torque urgently. Torque the screws in accordance with the picture. Pressure ring plate communicates only with the cover plate of gerotor type charge pump. Some space should be left between pressure ring plate and the end cap of main pump. Keep the screw torque urgently! In case of disregard of the given instructions the misuse failure of charge pump and main pump elements is possible.

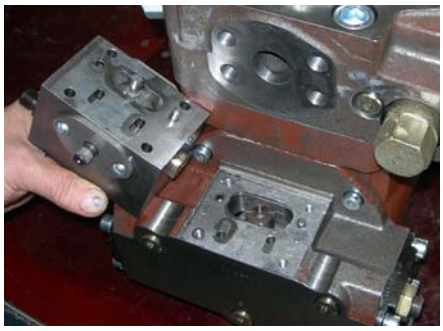


● Replacement of Proportional Servo Control.





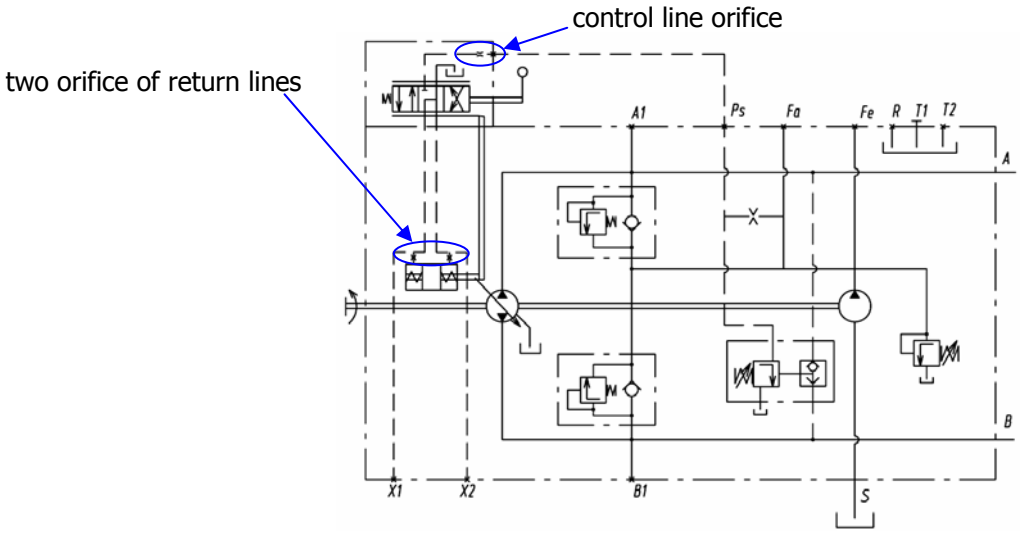
» Disconnect the charge pipeline (external hex 17mm).
» Turn the four screws out (internal hex 5mm) and take the Servo Control off.



» Install the new laying.
» Install the new Servo Control. Check the finger sphere of mechanism's reaction matching with servo piston's dog hole.
» Torque the 4 screws = 10±2Nm.
» Install the fitting into the new Servo Control. Torque = 20±2Nm.
» Install the charge pipeline in the fitting. Torque the pipeline's screw = 20±2Nm.

●The same above mentioned procedures are used for replacing the following mechanisms:
- proportional hydraulic control.
- proportional electro control without feedback.
- 3 position discrete electro control.
- proportional electro control.

- Orifice.



Control line orifice checking.

» Disconnect the control line pipe (external hex 17mm).
» Turn the fitting out of the control mechanism (external hex 17mm).
» Unscrew the orifice out of the control mechanism's housing by the screwdriver.
» Check the orifice hole for cleanliness. Unplug in case of dirt.
» Install the orifice into the control mechanism's housing.
» Install the fitting. Torque = 20±2Nm.
» Install the pipeline. Torque = 20±2Nm.

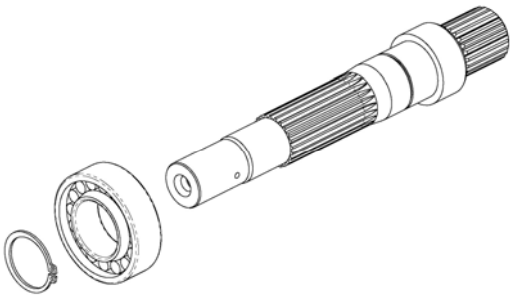
Return lines' orifice checking.

» Turn the plug out (internal hex 6mm).
» Turn the orifice out of servo regulator's housing.
» Check the orifice hole for cleanliness. Unplug in case of dirt.
» Install the orifice into the servo regulator's housing.
» Install the plug. Torque = 35±3Nm.

- Basic Repair of Hydraulic Motors
- Hydraulic Motor Shaft and Shaft Sealing Replacement.

» Take the locking ring off.

» Take the shaft assembly (shaft, bearing and seal plate) out of the hydraulic motor housing.
» Replace the seal for the new one.
» Replace the seal ring of the seal plate for the new one.
» Check the working area of shaft and seal surface contact. Replace the shaft in case of wearing.
» Install the shaft assembly into the hydraulic motor in case when the shaft replacement is not necessary.



» Take the locking ring off the shaft.
» Take the roller bearing off the shaft and install it on the new one.
» Install the locking ring on the new shaft.
» Install the new shaft assembly into the motor.

» Install the seal ring of the seal cover plate.
» Set the tapered mandrel for seal fixing on the shaft.
» Grease the following parts with working fluid before seal cover plate installation:
- mandrel surface;
- shaft surface in the area of seal contact;
- cutting edge of the seal;
- seal ring of the seal cover plate.
» Install the seal cover plate into the motor housing.

» Install the locking ring.

● Purge Relief Valve Replacement.

It is recommended to mark the lock nut position relating to end cape and valve casing before the replacement of purge relief valve. Install the valve in accord with the mark and set the pressure in case when the purge relief valve replacement is not required.

» Ease off the lock nut of purge relief valve (external hex 27mm).
» Turn the valve out of the end cap of motor (external hex 13mm).
» Check the sealing edge in the end cap of the motor (seat) for cleanliness and defects.
» Install the new valve. Torque the lock nut of the valve = 50Nm.
» Adjust the valve.

● Loop Flushing Valve Replacement.

» Unscrew the two plugs closing the spool (external hex 27mm).
» Take the two springs out.
» Take the spool out, two bushing.

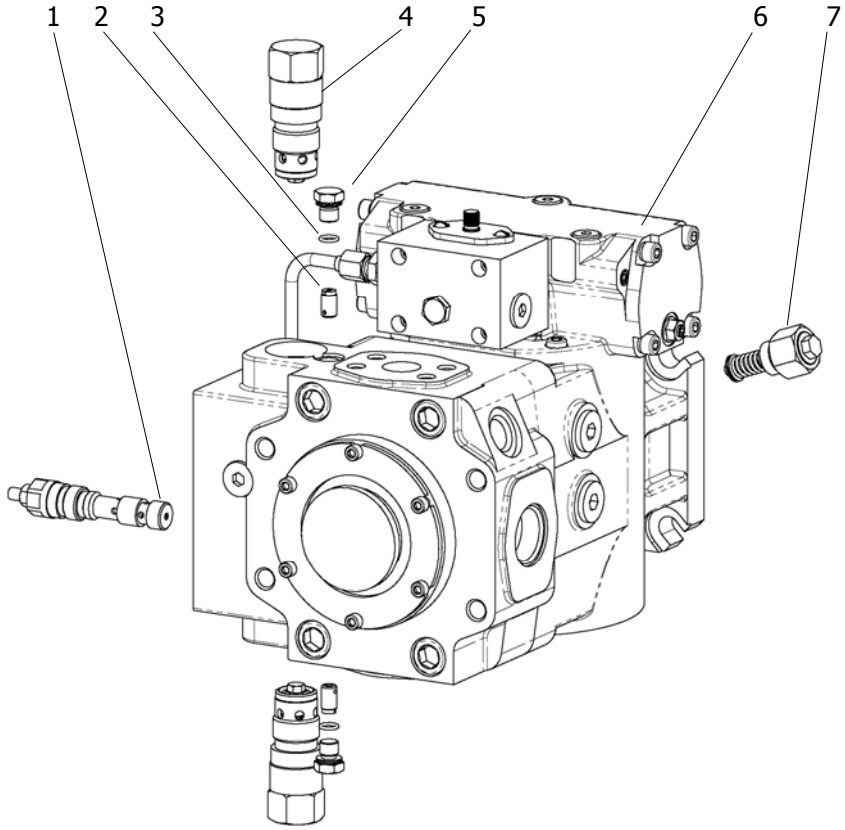
» Check the spool hole in the end cap of hydraulic motor for defects and cleanliness.
» Install the new spool.
» Install the bushing.
» Install the springs and plugs. Torque the plugs = 100±10Nm.

Parts Catalogue.

● 416.0.71 and 416.0.90 Variable Displacement Pumps.

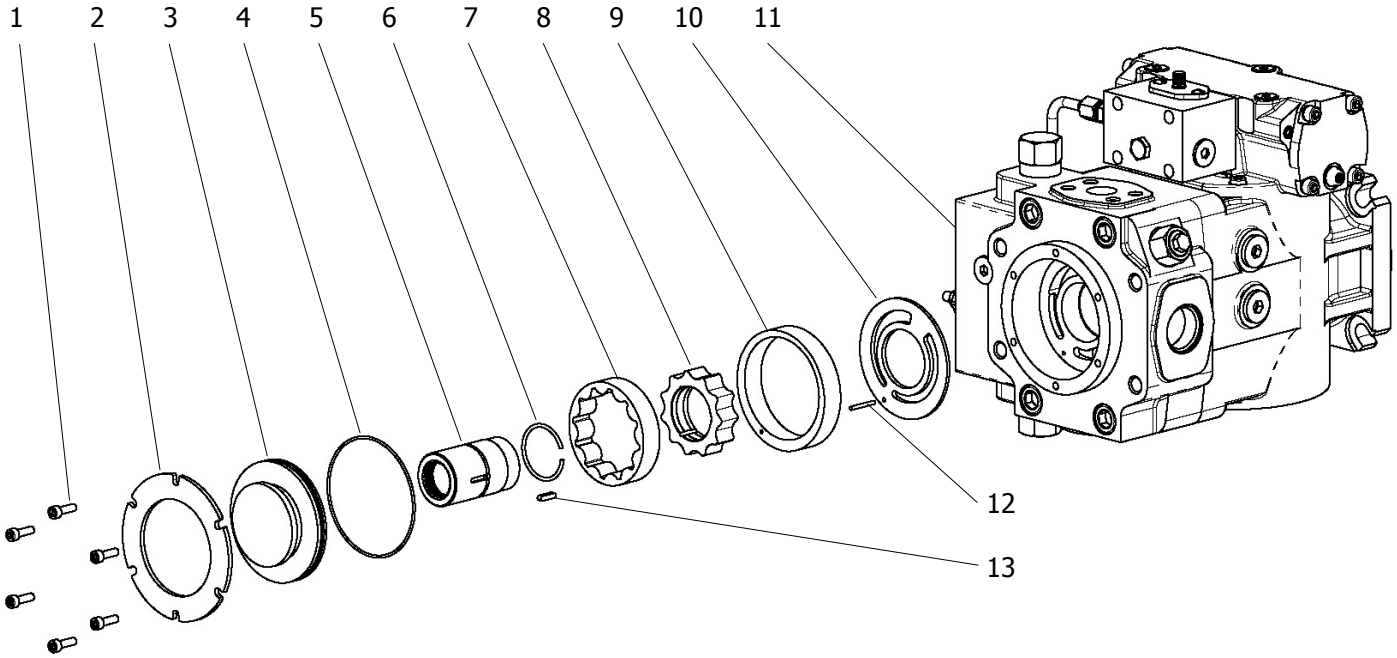
The pumps 71 and 90 ccm/rev (working volumes) are designed with maximum unification.
The pumps are distinguished by servo regulators types.

Built-in valves.



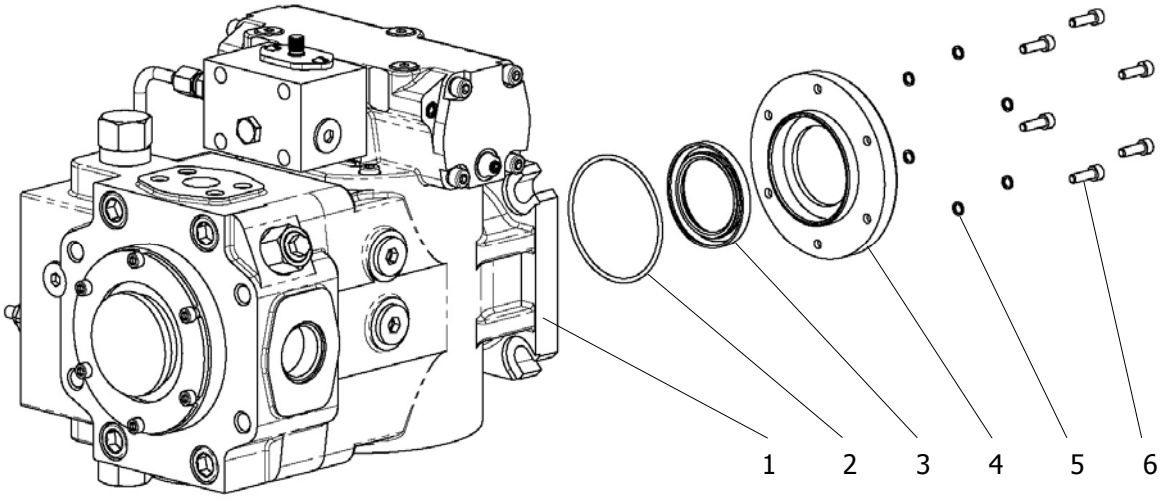
	description	identification	quantity
1	Cut-off valve	4160.90.77.00120	1
2	Check valve	4160.90.77.00240	2
3	Seal ring	009-013-25-2-2 national standard 18829	2
4	Pressure relief safety valve	OPK-16.000-03	2
5	Plug	HN 8-OR M12x1,5 DIN ISO 6149-2	2
6	Pump	416.0.71 or 416.0.90	1
7	Charge pressure valve	4160.90.77.00140	1

Charge Pump.



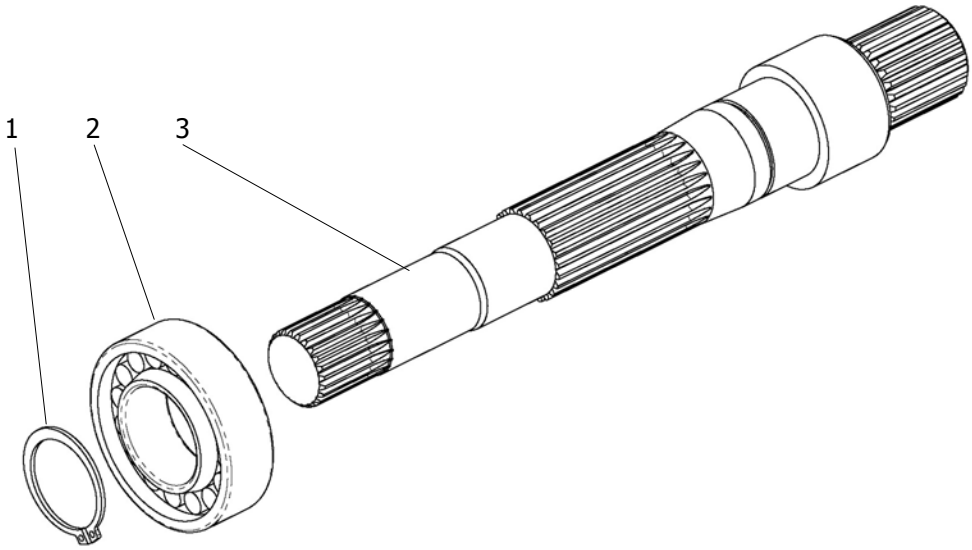
	description	identification	quantity
1	Screw	M6x20-12.9-A3K ISO 4762	6
2	Pressure ring plate	4160.90.77.00049	1
3	Cover plate	4160.90.77.00055	1
4	Seal ring	098-102-25-2-2 national standard 18829	1
5	Splined bushing	4160.90.77.00042	1
6	Thrust ring	RW45 DIN 7993	1
7	Wheel	4160.90.77.00051	1
8	Gear	4160.90.77.00052	1
9	Ring	4160.90.77.00053	1
10	Spacer	4160.90.77.00054	1
11	Pump	416.0.71 or 416.0.90	1
12	Pin	3m6x32 DIN 6325	1
13	Key (cotter)	A 4x4x18 DIN 6885	1

Shaft Sealing.



	description	identification	quantity
1	Pump	416.0.71 or 416.0.90	1
2	Seal ring	082-088-36-2-2 ГОСТ 18829	1
3	Seal	Simmering BABSL d50; D72; b7	1
4	Seal cover plate	4160.90.77.00018 (Ø152.4mm)	1
		4160.90.77.00018-01 (Ø127mm)	
5	Ring plate	6 65Г 019 national standard 6402	6
6	Screw	M6x20-12.9-A3K ISO 4762	6

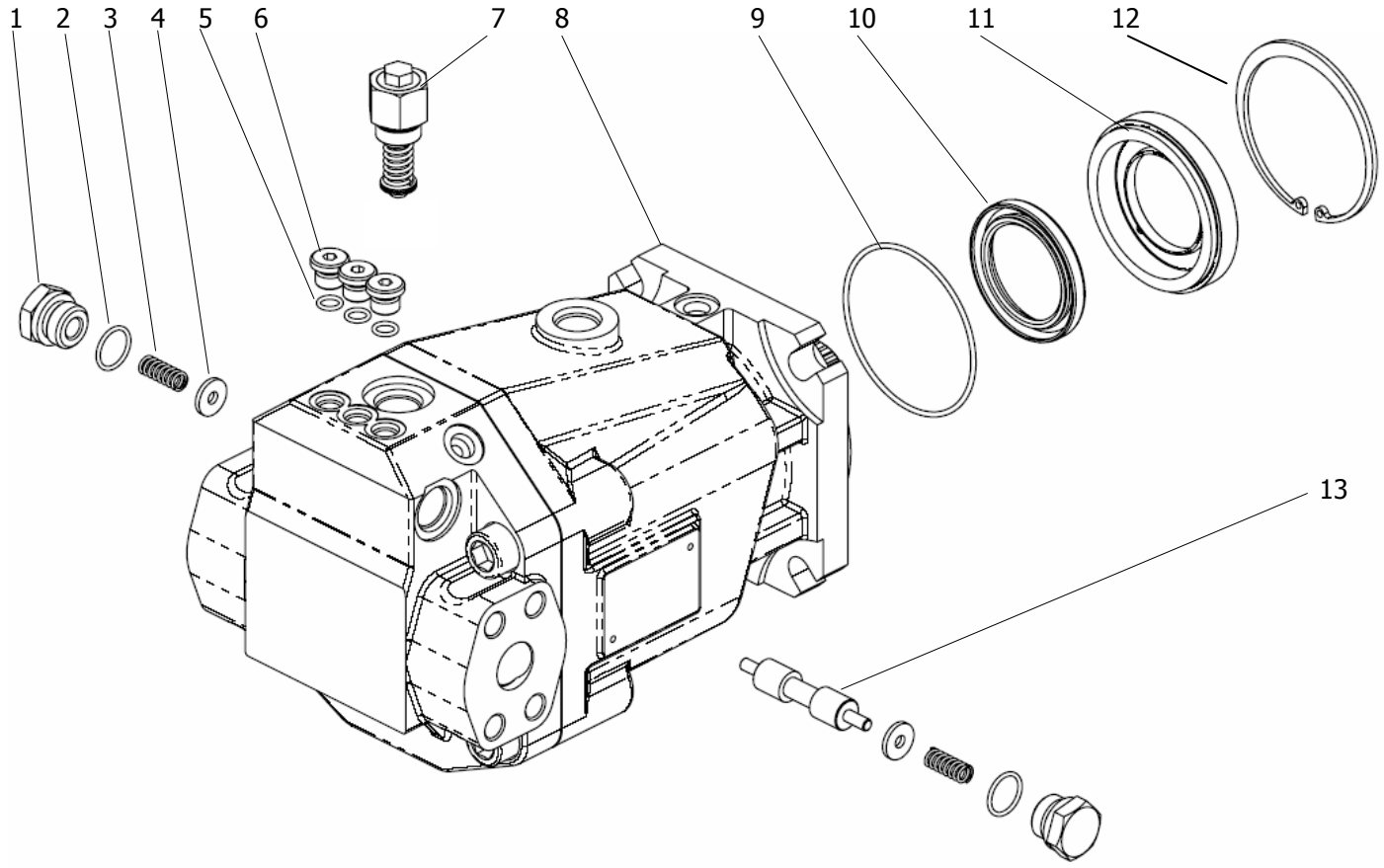
Shaft Assembly.



	description	identification	quantity
1	Thrust ring	40x1,75 DIN 471	1
2	Bearing	76-592708M1	1
3	Shaft 35x2x30x16x9g DIN5480	4160.90.77.00015	1
	Shaft 45x2x30x21x9g DIN5480	4160.90.77.00015-01	
	Shaft 13T 8/16 pitch ANSIB92	4160.90.77.00015-02	
	Shaft 14T 12/24 pitch ANSI B92	4160.90.77.00015-03	
	Shaft 23T 16/32 pitch ANSI B92	4160.90.77.00015-04	
	Shaft 21T 16/32 pitch ANSI B92	4160.90.77.00015-05	

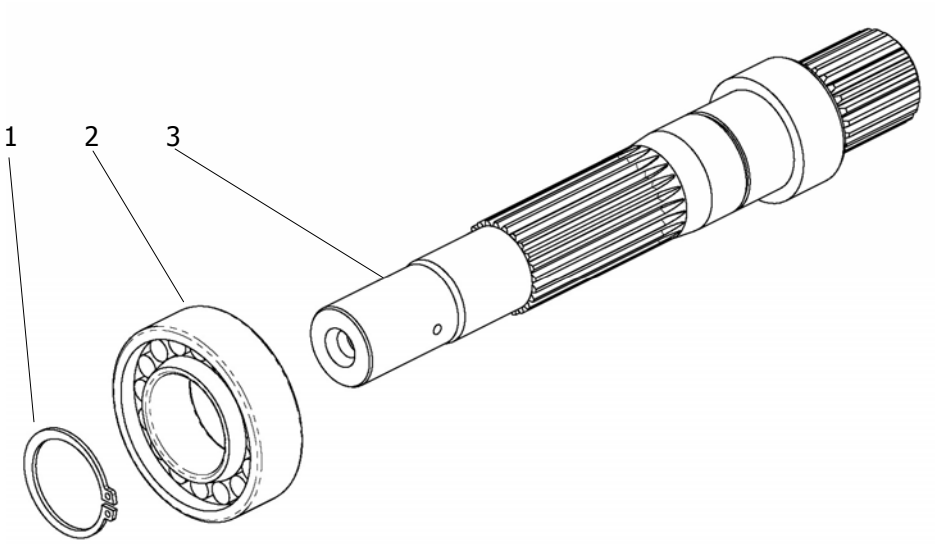
● 406.0.71 and 406.0.90 Fixed Displacement Hydraulic Motors.

The motors 71 and 90 ccm/rev (working volumes) are designed with maximum unification.
The motors are distinguished by housings types.



	description	identification	quantity
1	Cover plate	4060.90.20.00009	2
2	Seal ring	019-023-25-2-2 national standard 18829	2
3	Spring	BP.00.006	2
4	Bushing	310.3.56.19.01011	2
5	Seal ring	009-013-25-2-2 national standard 18829	3
6	Plug	HN 8-OR M12x1,5 DIN ISO 6149-2	3
7	Purge relief valve	4160.90.77.00140	1
8	Hydraulic motor	406.0.71 or 406.0.90	1
9	Seal ring	085-090-30-2-2 national standard18829	1
10	Seal	Simmering BABSL d50; D72; b7	1
11	Seal cover plate	4060.90.20.00014	1
12	Thrust ring	JS90 DIN 472	1
13	Spool	310.3.56.19.01009	1

Shaft Assembly.



	description	identification	quantity
1	Thrust ring	40x1,75 DIN 471	1
2	Bearing	76-592708M1	1
3	Shaft 23T 16/32 pitch ANSI B92	4060.90.20.00004	1
	Shaft 21T 16/32 pitch ANSI B92	4060.90.20.00004-01	
	Shaft 45x2x30x21x9g DIN 5480	4060.90.20.00004-02	
	Shaft 35x2x30x16x9g DIN 5480	4060.90.20.00004-03	